THE

ELECTRICAL REVIEW.

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THE STUDY OF ELECTRICAL ENGINEERING.

A CONTEMPORARY has lately been devoting some space to the much-discussed, but still vexed question, of the course to be pursued by aspirants desirous of meriting the title of electrical engineer. Good service can be done on their behalf, and on that of the profession, by permitting those willing and competent to express their opinions, to put forward what they consider to be the main channel, with the shoals, quicksands, and rocks which lie on and around the track of beginners. The most difficult thing for the lad choosing a calling is to know not so much which to decide upon, as to obtain reliable information upon which he would himself, or his relatives for him, make a selection.

The important feature, in the present instance, is the publication of the opinions of those who are themselves large employers of labour. Of this labour, a considerable percentage is of the class whose training is under discussion. A simple answer to the question would therefore be:—The best and most suitable training for positions included in the calling of an electrical engineer is that which meets the views of likely firms—possible employers—and therefore renders the embryo electrical engineer favourable in the sight of those who alone can place him in positions of the kind he seeks.

It is interesting to average what such opinion is, for professors and training colleges must clearly, to produce a marketable article, model their manufacturing processes so as to meet the average views of those requiring, or who may require, the services of such as have been trained or primed with scientific or technical lore. We must dissent strongly from the view put forward by one of the writers in the columns of our contemporary when he suggests that electrical knowledge is what salaries are paid for. Further, the distinction he draws between an "apprentice" and an "articled pupil" is not likely to find favour with those who have passed "the third degree" in the electrical industry. Only the slightest importance is attached to such a distinction, which is of value not in itself, but in what it represents, as will be pointed out presently.

Let us suppose two lads of fifteen or sixteen years of age enter the shops of a well-to-do firm engaged in mechanical, electrical, contracting and manufacturing work, the one the son of a better class mechanic or artisan, and the other that of a professional or business man having an income of, say, one thousand a year. Wherein will the positions of the two lads differ? It may fairly be taken that now-a-days a few pence a week will enable one to obtain as good an education as can be bought at any price for lads at such an age. Under these circumstances the chances of the two seem but proportional to their abilities. In other words they are both "scratched" in their start for the prizes to be gained in the race of life.

During their apprenticeship it is a case of neck-and-neck run ; neither need have a decided lead. So the years pass away, and they emerge from their probation to seek fortune's smiles as equally well qualified electrical engineers. Now, at this point something wonderful happens. The one is seen to take up an appointment as assistant engineer to some company, lighting station, or corporation, while the other is compelled to become a journeyman, or starve. This is the point so often lost sight of in discussing the question at the head of this article. The all important factor is *not* the exact course of training, *but* given a fair training and a receptive head on the shoulders of the beginner, what influence can be brought to bear in obtaining for him a preference over the host of other applicants for every vacancy on the "staff." This is the one thing which lifts one of the twain to the position of a young engineer—a professional man—a representative of the masters' interests, and leaves the other but the dry bread of a weekly wage and a trade. The premium pupil gains one thing by his ability to pay what are usually large sums to his firm ; and that one thing is, he establishes his individuality from the first. He is Mr. So-and-so ; incidentally he is given the run of the shops, the entrance to the drawing office is open to him, and if he be at all anxious to make use of his opportunities, the commercial and "cost" knowledge he can gain in this way would be worth far more than the premium which had to be laid down to enable him to obtain it. This may all appear very hard and even be considered an undue forcing of class privileges, but will anyone with a knowledge of the facts attempt to deny it ? Over and over again this feature in the training of men in the various branches of engineering industry has been shown to be *the* one, not merely be it noted a help to the favoured patrician, but by its presence or absence deciding the fate of each one as he emerges from the training period. Of course there are exceptions, without them there would be no rule ; but recent action on the part of a certain institute has exemplified the truth of the foregoing in a startling manner. The man with a few hundred pounds at his disposal may, with reasonable attention to his own interests, become an electrical engineer at a salary at least superior to a first-class workman, be on the staff and be considered a gentleman, with every prospect before him of a respectable and comfortable life. Without such a capital or its equivalent of friends in high places, another and more brilliant individual remains No. *n*th on the time sheet, and by the force of circumstances hemming him in on every side, he is restrained from even reaching the bottom rung of the ladder, higher up on which he sees old shop comrades and those who in former days were "Hail fellow, well met" with him.

To return to the course of training best suited to enable one possessed of the advantages enumerated to utilise them to the full for his own benefit and that of his coming employers, the fact cannot be pressed home too closely that in central stations, electric traction operations, and still more during the manufacture of plant, the leading requirement is a good sound mechanical training.

This does not necessarily imply a deep study of the steam engine, or a tedious spell in a mechanical engineer's works, but it does enforce having spent, at least, some years in the operations incidental to the creation and repair of the appliances over which, at a later date, the pupil or apprentice hopes to exercise control. The craftsmanship displayed by the aspirant at the end of his shop training need not be of a very high order, provided that it is such that he could earn his livelihood, if ever necessary, by its use. The knowledge in each department through whose portals he has passed, should be as sound and thorough as by his own efforts and the facilities for gaining experience permit. This will vary with different works and firms, and even with a single firm at different periods of its career ; but if a modicum of care be taken in the first place, the finished product will possess a commercial value, and it is this alone which will stamp the course pursued in the meantime as being a suitable and satisfactory one.

The subject is one which has an interest at all times during the continuance of the industry, and it has been treated in many ways, with different objects, and by the pens of some of the most eminent men in the profession ; still the ball rolls on. Now and then it gets a kick one way or the other, but all the while colleges scoop in fees of one hundred guineas per head per annum by the score ; works their dozens of premiums, some higher some lower than this ; and the cry of electricity in its infancy brings still further crowds to fatten upon its sinecures.

Sinecures are not always forthcoming, but in other cases the fattening process proceeds without visible result—now and then the result requiring a minus sign before it to express the value correctly.

The utterances of speakers and writers on a question of present-day interest is, like the times in which they live, apt to be flavoured with self-aggrandisement and advancement ; and, on a matter of training, the views put forth by individuals are those most conducive to their own ends. It would be well for would-be dabblers in electrotechnics to ascertain their chances of obtaining their share of the "common lot it is our duty to perform," for, with all the will in the world, others before them have found it hard to obtain. Should they then determine to embark in the calling, they would be well-advised were they to go in for mechanical training thoroughly ; obtaining a proficiency in drawing office work and superimposing upon such a reliable foundation, the knowledge of thermo-dynamics (theory of heat and operation of steam in the steam engine), chemistry, mechanics and theory of electro-dynamics which, with some practice in electric measurement, can easily be obtained in any of our large towns by evening classes or private study, supplemented, if desirable, by a year's course after leaving the works.

This we believe to be not only the best course from the advantage to be gained by such as follow it, but also that most likely to give the beginner a wide field to choose from when he comes to start as a wage-earner or salaried officer upon special work.

By all means let him become a specialist, but the time for this is after, not before his entrance upon the sphere of practical work. High achievements and the flights which lead to success are almost always of the specialist kind, but were one to do so at an early stage, the tendency would be overpowering to drop into a groove, and by limiting one's greatest attention to one subject by concentrating the best of one's energies upon it, lose sight of the rest of the field before knowing the general configuration of the country, and the nature of surrounding lands.

THE LAMP SITUATION IN AMERICA.

Matters do not seem to be quieting down with our electrical confrères "out West." Mr. F. S. Terry, manager of the Ansonia Electrical Company, of Chicago, is very wroth against the General Electric Company, as being the instrument by which his business is diminishing in an alarming manner, and he has written to the *Electrical World* vehemently expressing his hope that that organ will open its columns to the discussion of the situation. He hopes that the electrical papers at least will not suppress the recent discussion on the subject that took place at the St. Louis Convention—see Mr. Townley's paper, commented on in our issue for April 7th—as he understands will be the case in the official reports of the Convention. He concludes by suggesting the two following questions as being especially suitable for discussion :—

1. Is it possible for the General Electric Company to obtain control of the lighting industry ?

2. Should the General Electric Company obtain control of the lighting industry, would the effect on the lighting business on the whole be beneficial or otherwise ?

In reference to this letter the editors of the *Electrical World* state that they reported the discussion in question very fully, and they also announce that the columns of their paper are open for brief contributions on this as well as on other subjects of importance to the industry. They further endeavoured to meet Mr. Terry's wishes by sending copies of that gentleman's letter to a number of the more prominent engineers and managers engaged in the trade. The replies they have received were couched in very cautious language, and very various opinions are naturally expressed.

One expert, who is stated to be well qualified to speak on the subject, thinks it is hardly possible for the General Company to acquire the control of the whole industry ; and as regards the desirability of such control, he is distinctly adverse to it. A well known manager of a manufacturing company is emphatically in favour of free and fair discussion of the subject for the sake of all concerned. A central station man considers that the effect of entire control would depend entirely upon the honesty and integrity of the General Company itself, but he does not seem to be wholly convinced that the monster company is abundantly endowed with those desirable qualities. Mr. Upton, whose name is so conspicuously known in connection with the Edison interests, does not see how the General Company can possibly monopolise the whole industry seeing how many requisites are quite uncontrollable. He has followed the history of the art from its commencement and well knows the obligation the industry is under to Mr. Edison ; and he considers that Mr. Terry need only fear monopoly as regards the lamp branch of the industry. He fails to see grounds for complaint at a situation, as regards incandescent lamps, which Mr. Terry and others should have known was sure to come about. Another gentleman, stated to be eminently fitted to express an opinion, considers that it will be quite possible for the General Company to obtain absolute control of the lamp business for a time, for he is doubtful as to the success of the Western lamp manufacturers to throw the lamp market open, by means of the pending litigation. As regards the control of the whole lighting industry, his individual opinion is that it would not be beneficial and it is not likely to come about any more than it did in England ; but in this connection we would remark that company amalgamations have not been quite as rife in this country as in the States. He thinks the main difficulty the General Company would meet with in seeking to control the electrical industries would be a financial one. The case might have been otherwise had the Edison people exhibited faith in their patent earlier. Had they enforced their claims at the outset, as the Bell Telephone Company did, they might now have been in a very strong position.

The consensus of opinion, therefore, seems to be that the General Company is unlikely to wield sway over anything but a large branch of the industry, and we trust it will be limited to this. But we would go a little further in expressing our opinion and say, in reference to Mr. Upton's remarks, that the hard, shall we not equally correctly say *unfair* phase of the matter *originales* in the tardy assertion of the Edison patent. To us it seems a gross injustice to allow an industry to develop unchecked for a considerable number of years and then all of a sudden to crush out all competitors. The company may have *legal* right on its side in the present case, but the sooner some law is passed in all countries where patent rights exist, compelling a patentee to grant licenses to outside manufacturers under reasonable royalty in case his patent is not asserted within a given period from the date of issue, the sooner, in our opinion, will another step be taken towards equity and justice.

The Wiring of Houses for the Electric Light.

In the *Western Electrician*, of March 18th, of this year, Mr. Charles G. Armstrong drew attention to some interesting points in connection with this subject in an article entitled "Electric Installations, and some Radical Changes in General Systems of Wiring." The principal radical change suggested is to bunch all distributing wires irrespective of size or polarity together in one pipe, conduit, or "raceway." This conduit or raceway to be lined with asbestos paper and painted with several coats of good fireproof paint, or made altogether of fireproof material. The greatest current allowable on one circuit would be 8 ampères. That the bunching of wires is a radical change no one will deny, but it is at first difficult to see why this system has not been suggested before. Combined with suitable precautions there should be no danger attending the running of wires for lighting purposes inside a building in this way. The main sources of danger in electric wiring are leakage of current between two wires at different potentials, and from wires to earth. It will be admitted that leaks to earth always exist to a greater or less degree, and it is idle to argue for perfect insulation resistance of a system of wires in a house if these wires are subsequently to be connected to a supply company's mains whose insulation resistance is comparatively low. There is no danger to be apprehended from leaks to earth as long as the degree is kept below a limit above which the current flowing to earth is so small as to be harmless. Undoubtedly, progress in electric wiring systems has been much hampered by the arbitrary restrictions laid down by fire insurance companies who, instead of striving to know their real position, have always kept on "the safe side." Now, a banker is quite justified in keeping on the safe side as regards the quality of security he accepts for the loan he makes his clients, and so, it is argued, the insurance company have to think of their shareholders, and are, therefore, perfectly justified in only permitting a system they know to be safe.

Carrying this to its logical conclusion, they should not allow electric wiring at all, for that would certainly be the safest way to avoid risks from defects in electric wiring.

A New External Electrode.

The New York *Electrical Review* for April 8th contains a description of a new form of electrode for external use, which has much to recommend it when strong currents are employed upon the body. The article in which it is described goes somewhat out of its way to decry the value of other forms of electrodes, whereas, with the small and moderate currents that form the staple requirement of the electro-therapist, the sponge electrode is by many considered far and away the most convenient and handy. When, however, such strong currents as 100 ma. are needed, and we believe it is only in connection with such semi-surgical operations in gynæcology as are classed under the head of "Apostoli's Treatment," that this strength of current is reached, special forms of electrode, having large and uniform contact area, must be adopted. Hitherto the clay electrode seems to have found the greatest favour with gynæcologists, and it is clear that almost any form which can equal the advantages of the clay without all the mess and discomfort inseparable from its use must be an improvement. The new electrode (called Brown's, after its inventor) seems to be far superior to the old clay electrode, for it claims to give uniform contact over a considerable area, allows no superfluous moisture to escape, can be quickly prepared and easily adjusted to any shaped surface. It consists briefly of a flat piece of amadou, "a substance which grows upon old trees in England and on the continent of Europe," which readily takes up "more than its weight of water and in so doing contracts to at least half its former size. When saturated with water it has a fleshy touch and will readily conform to the irregularities of the body." Upon this pad a plaque of perforated brass, which has previously undergone a process of annealing, is laid, having attached to it various connecting clips and wires which we need not here describe. The whole electrode is kept in position by pressure from a sand bag or any other suitable means. We are not told anything about the resistance of this amadou, and should rather expect it is consi lerable, even when suitably moistened. This, however, would be a secondary matter when a battery of high E.M.F. is employed. The advisability of using perforated brass which must be specially annealed to make it pliable, is open to question when rolled tin can be obtained quite as pliable if rolled reasonably thin. The "Brown" electrode is a decided advance upon many special electrodes and, moreover, possesses the great merit of simplicity.

The "Incandescent Arc" Lamp as a Rival o the Incandescent Lamp.

Mr. Augustus Noll, in the *Electrical Engineer* of New York, of March 22nd, remarks upon the economy to be effected by the arc lamp as compared with the incandescent lamp, on the basis of watts per candle. He works out some examples numerically, and finds that for the same total candle-power there is a difference of 12 to 1 in favour of the arc lamp. On examining the figures we find that a 16 C.P. lamp is assumed to take 50 watts, and that an arc lamp taking 8 ampères will yield 1,500 candle-power. Vague and unfounded statements have always been made about the candle-power of arc lamps, but it is certainly unwise to argue with figures when the accuracy of the figures leaves so very much to be desired. It is possible that at one particular angle in one particular plane, the candle-power of an 8-ampère arc lamp may rise considerably above the average, but it is improbable that the above figure is ever attained in an 8-ampère arc lamp. That a given total illuminating effect can be attained more cheaply by an arc light than by incandescent lamps, no one would ever think of even questioning; but economy in money cost must be considered, together with expediency, convenience, and even necessity. This is particularly important in the class of lighting about which Mr. Noll argues, namely, shop lighting. Imagine any tastefully dressed shop window being lighted by arc lamps! In America there has always existed a craze for doing things on a large scale, but the effect of lighting, say, a jeweller's window with arc lamps would appeal, we think, even to an American jeweller. In some recent photometric experiments on the candle-power of an arc lamp, taking 6½ ampères a maximum, illuminating power of about 750 candles was measured, but at the same angle the candle-power varied very considerably as the arc travelled round, the mean intensity being only 350 candles. This is not cited as showing the degree of unreliability of the alleged candle-power of the ordinary arc lamp, but it is one sample of how terribly far practice may fall short of theory. Some years ago 10-ampère lamps were commonly spoken of as giving 2,000 candle-power. Mr. W. J. Dibdin did yeoman service in proving that these statements were the result of conjecture (perhaps perfectly honest conjecture) on the part of the patentee, but were in no sense borne out when compared with the inexorable "standard 10 candles." The question of the relative practical efficiency of arc and incandescent lighting is a very complex one, inasmuch as it seldom occurs that the conditions of lighting are such that either arc or incandescent lighting would suit equally well. Moreover there is very great difficulty in deciding upon a standard intensity of general illumination and in measuring the amount of general illumination; obviously, the photometer does not furnish the best possible means of measurement of illuminating intensities for the purposes of comparison on a practical general scale.

Gas and Electricity.

The *Western Electrician* of March 8th has a short article on the relative consumption of gas for a given total illuminating effect when burnt in gas burners and when used in a gas engine which drives a dynamo producing current for 16 C.P. incandescent lamps. These latter are assumed to yield 16 C.P. for a consumption of energy at the rate of 50 watts. The result of the argument is to show an actual gain of 71·42 per cent. when gas is consumed in an engine. Mr. Emerson Dowson in his recent paper read before the members of the Institution of Civil Engineers, in which he assumed that his cheap motive power gas was used, claimed an economy of 50 per cent. Mr. Dowson's assumption of a 50 per cent. economy, is equivalent to an actual gain of 100 per cent. from the same standpoint as the above 71 per cent. is viewed. This is not the place to criticise Mr. Dowson's figures, but if gas burnt in an argand burner is taken as a basis for comparison, electric light as yielded by the arc lamp should be compared with it, whereas the performance of the ordinary incandescent lamp may justly be compared with gas burnt in ordinary everyday burners. A comparison such as that made by the *Western Electrician* is very good as far as it goes, but it really does not go far at all. It is an almost purely theoretical conclusion and does not take into account the many details which are absolutely essential to the formation of a sound opinion on the merits of using gas in these ways in practice. There is every hope that Mr. Dowson's suggestion, during the discussion that followed the reading of his paper, will be taken up seriously and that we may have before very long the results of a series of tests made under conditions simulating as nearly as possible practical conditions, from which it will then be possible to deduce the real practical economy of gas power for the production of electrical energy.

APPLICATIONS OF OZONE.

[FROM A CORRESPONDENT.]

APPENDIX—(*concluded from page* 478.)

Heat.—A very little known paper of the *Archives Néeirlandaises des Sciences* (Vol. 3, p. 260), gives an account of an essay, awarded a prize by the Society of Arts and Sciences, of Utrecht, in 1868, on the "Calorific Equivalent of Ozone." It was very difficult to ascertain the quantity of gases burnt by ozone and by oxygen comparatively, because the ozonised air contains a very small amount of ozone, and also because ozone has a peculiar affinity for each substance, so that it is not easy to unite it precisely with such or such substance particularly.

The experiment made by Dr. H., author of the essay (his name is not mentioned), proved that the combustion of 1 gramme of hydrogen, under the action of oxygen, produces 34,451 *calories*, and that when ozonised air is used, it produces 34,595·6 units of heat, *i.e.*, 44·6 *units more*. His conclusions were that 1 litre of hydrogen combined with ozonised oxygen containing $\frac{1}{46}$th of ozone liberates 3,091 calories, and that as 1 gramme of hydrogen unites with 8 grammes of oxygen to form water, the equation, 44·6 units $\times$ 62 = 346, which is the calorific equivalent of ozone. Experiments were not carried further in that direction on a large scale, but it can be safely asserted that,

High Temperatures for metallurgical and other purposes are obtained by substituting ozone for air or oxygen, and that the cost of ozonised air or oxygen is almost nominal.

Catalysis.—Porous substances act in a peculiar way upon ozone, which is destroyed if it is slowly passed through a glass tube filled up with asbestos, spongy platinum, lint, carded cotton, flannel, &c. In such a case ozone loses its odour and its properties.

Bleaching.—The truth about bleaching by ozone is really that unless applied in certain conditions, in a certain manner, it does not bleach at all, and probably there is not in the world a man who can say that he has bleached, or has seen bleached by ozone alone, a ton, or even half a ton, of paper pulp in a manner which competes for time and money with the common chloride of lime. Alone, ozone does not decolourise in any manner approaching the rapidity with which it destroys or disintegrates India-rubber. There is a way to do it, or rather there are several methods, which are more or less unknown, for decolourising by ozone animal and vegetable fibres or materials.

The combination of ozone with chlorine, recommended in 1886 or 1887 by Dr. Thorne, is, up to the present, the best. Ozone passed through a potcher containing a weak hypochlorite of calcium solution bleaches rapidly. Nitrogen retards the bleaching; atmospheric air or oxygen does not help at all. The saving in bleaching paper pulp by means of ozone and hypochlorite solution is indeed considerable and represents 40 to 50 per cent.

Dr. Thorne said also, at the Society of Chemical Industry, that more than 50 tons of esparto, straw, and pulp were bleached in this manner by him in open potchers at a cost of about 200 cubic feet of active oxygen, *i.e.*, of ozone forced through an hypochlorite of sodium solution. With chlorine, ozone acts identically; a considerable quantity is absorbed and a saving of about 50 per cent. is effected. This last observation is worth special attention.

Many people know ozone by repute only; most of what has been published on ozone has been copied from books written years ago. I have been also one of those who had false ideas and no knowledge of ozone, and I feel ashamed when I remember what I wrote a few years ago on ozone and on its non-bleaching properties. The fact is that the greatest disappointment a man can experience is to find that after he has passed ozone for a few hours through a recipient containing wool, cotton or paper pulp, there is almost no change in the appearance of the material. The explanation of these negative results is, that with ozone, as with many other things, there is a way to use it and to apply it, and there is, so to speak, an art of bleaching vegetable fabrics by means of ozone which destroys the colouring matter, but does not attack the cellulose.

F. Goppelschröder, the discoverer of the production of dyes by electrolysis, stated in 1875 that a damp tissue is decolourised by ozone at the ordinary temperature, and that a dry one is not. He added that if the tissue has been dipped in water, and has been submitted to a temperature below freezing, this does not prevent the action of ozone, which attacks not only indigo blue, but changes aniline brown into yellow orange. Cochineal red on wool is only weakened; corallin yellow, iodine green, fuchsin pink, Hoffman violet and blue are slowly decolourised, as well as Turkey red and several colours obtained from dyewoods. Alizarine patterns on a black and grey ground turn white, but the grey and black resist the action of ozone. Violet madder is quickly attacked and presents a yellowish hue; many red, rose, pink, brown, and black calico patterns lose their bright colour and show only a light tint due to mordantine. The ozone used by Goppelschröder was produced from phosphorus, as there were no means in 1875 to generate ozone in sufficient quantities, even for making such small experiments.

The conclusion of the Alsatian electro-chemist was that ozone will play an important rôle in the bleaching of textiles and fibres.

I recently saw in a chemical review that Schwann, in America, was the first to utilise ozone in the manufacture of soap, simply by passing, during 5 minutes, ozone through cold tallow and caustic soda. I could not help being much surprised and incredulous, and I made researches which showed me that Schwann had never made use of ozone in the manufacture of soap.

The disinfection and sterilisation of water constitute one of the most remarkable properties of ozone, and it has been established beyond doubt that the most impure water can be rendered perfectly fit and pleasant for drinking by the use of this agent. Other properties of great value have been shown to belong to ozone, fitting it to act as a hygienic and therapeutic agent. It has been experimentally proved to be powerfully antiseptic, being very destructive of pathogenic organisms; and, further, its inhalation is found to be of great value in condition of anemia and depressed vitality.

As ozone exists naturally in the atmosphere over the sea, about hilltops, and elsewhere, it has been rightly designated nature's disinfectant, and presents this extraordinary advantage over all disinfectants, that while destroying the deleterious matters or organisms in the atmosphere, at the same time it imparts to the air certain positive properties, rendering it more heathful and invigorating for respiration.

The great value of ozone has been abundantly demonstrated both as a disinfectant and stimulant in such diseases as phthisis, certain forms of bronchitis, catarrh, &c., and its disinfecting powers must be of great value in keeping the air sweet and pure, and so preventing the infection of wounds. The powerful properties of ozone for oxidising organic substances has been demonstrated so many times that its utility is beyond doubt. E. Chappuis has made experiments to show that ozone has the property of destroying the germs capable of causing fermentation, putrefaction and development of mildew. He collected dust from the air on cotton stoppers and some of these were submitted to the action of ozone. He brought them in contact with liquid beer yeast, which kept clear and limpid for more than 20 days, while non-ozonised cotton stoppers caused turbidity in a few days from the development of certain organisms. Therefore all the organisms in the air which can be developed in beer yeast are killed by ozone. Ozone, according to competent medical men and physicists, is not present in a contaminated atmosphere; on the contrary, the pure air which is blown from the sea contains ozone. There is no ozone in a town where a contagious disease rages, or even mildly commences to spread. Ozone reappears when the epidemic and the mortality has decreased.

"Living *contagia* are the agents of putrefaction," said Prof. Tyndall, to whom Dr. William Budd had written that the specific cause of contagious fever must be living organisms. Who would dare to contradict this declaration of Prof. Tyndall that "in cases of epidemic diseases it is not on *bad air* or *foul drains* that the physician of the future will primarily be fixed, but on *disease germs* which *no bad air or foul drains* can create, but which can be pushed by foul air into virulent energy of reproduction."

Disinfection.—I am not qualified, and I do not attempt to advocate the therapeutic application of ozone, but medical

authorities have pronounced their verdict that the therapeutic effects of ozone are beneficial, that oxygen in its nascent state, *i.e.*, ozone, cannot be but wholesome, that it has been successfully applied in malaria, in various diseases caused by the impurity of blood or depraved nutrition, as well as in the treatment of wounds. and that the most felicitous results have been obtained.

As long as it was impossible to produce ozone on a large scale, ozone has been left in abeyance, but its disinfecting properties have never been disputed. Its oxidising action makes it a most excellent purifier of air; when in sufficient quantities, it destroys many forms of organic germs which are dangerous and hurtful to animal life, or, at least, stops their development.

Organic matters, smoke, sulphur compounds, and other impurities with which the air we breathe is commonly vitiated, destroy ozone, *i.e.*, are in such disproportional quantity that they absorb all the ozone, which, if there was enough of it in the air, would sweep away these impurities. Let us have abundance of ozone in our houses, in public buildings, banks, offices, clubs, assembly rooms, &c., and it will remove these invisible enemies which surround us, or it will at least destroy their deleterious influence. How is it that ozone has not been used for disinfecting rags, the importation of which is the object of so many restrictions? Ozone cannot possibly be more unpleasant in a disinfecting room than sulphurous acid? Why is it not used for disinfecting travellers who come from countries where cholera or other infectious plague prevails? Ozonising installations are not expensive. An alternator, two or three transformers, and a few ozonisers disseminated in a trans-Atlantic steamer would render valuable services and deliver the passengers from the worry and trouble of a quarantine. Ozonising installations may be made on boats, which in the ports would be sent by the Sanitary Boards to disinfect the suspected vessels. Portable apparatus could be employed for disinfecting slaughter-houses, stables, cattle trucks, &c.

In February last, at the Old Bailey, the atmosphere was so close that the judge ordered the usher to open the windows, and the draught of cold air was such that the jurymen retired in a body without asking leave. A contemporary complained a few months ago of the unwholesome heat and stuffiness of the atmosphere in the British Museum reading room, and suggested that where men congregate, ozone would make a very considerable and noticeable difference in the healthiness of the place. How many places want ozone in London, even excluding the Houses of Parliament, the Law Courts, Guildhall, &c.?

There can be no mistake about a current of ozone clearing and purifying the most contaminated and impure atmosphere of crowded rooms. Let us hope that ozone apparatus will be fitted up in theatres, in hospital wards, in every place where people congregate and render the atmosphere close and foul. If by the use of ozone, half of the evil is eliminated, it will be already a boon.

There are a hundred uses for ozone, but I dare say we can neglect ninety-nine of them, or consider them as of little value, although they serve the purposes of commerce or industry, and we may be grateful if ozone has this one great virtue, that it protects us against pernicious or mephitic influences, or preserves or restores our health, or simply purifies the air in which we live.

There is at our disposal the oxidiser par excellence. Because it has not been applied before, shall we forget that it is at least worth our while to try it? Cholera precautions are taken in England, shall we not include ozone in the number of the prophylactic agents recommended by the medical authorities? most of these antiseptics are much more expensive and do not possess the same virtue. There is a great difference between an antiseptic and a disinfectant. An enquiry on this subject is necessary, but if it takes place the matter ought to be taken in hand at once, or else, if the cholera or other epidemics were breaking out, it would be too late to think of employing ozone.

No one can state that ozone destroys all germs and bacteria. This is an utopian idea, but if it prevents their action or protect the material on which they multiply, is it not quite sufficient? Disinfection by ozone is nothing else but the destruction of germs or the transformation of these germs and of decaying and putrescent organic matter into innocuous bodies.

Bacilli, Bacteria.—In my first article on the applications of ozone, I gave a *resumé* of the report of Dr. Fröhlich who each time he had to treat the question of the action of ozone on germs, spores and microbes, in infectious diseases, abstained from giving his opinion, stating that such questions were under the examination of the Imperial Sanitary Board.

I am glad to say in concluding this series of articles that in a report on the influence of ozone on bacteria, *Uber die Einwirkung des Ozons auf Bakterien*, published in the Proceedings of the Imperial German Sanitary Board (*Arbeiten aus dem Kaiserlichen Gesundheitamte*, T. viii., part 1., Dr. Ohlmuller has established the following facts which deserve the attention of scientists as well as of civic authorities and of the general public.

Anthrax, typhus and cholera bacilli, as well as anthrax spores, are destroyed within a few minutes by ozone.

Typhus and cholera bacilli, contained in sewage and water of the Spree, were destroyed. Ozone has no effect on dry bacteria and bacilli. Bacteria which have penetrated into the cells of paper, or in threads or tissues, are more difficult to attack and exterminate.

Two litres of ozonised air killed the bacilli which exist in pus, and living subjects inoculated with such ozonised pus rendered innocuous did not feel any inconvenience. In certain cases, the destruction of germs is a mere question of quantity of ozone, and if there have been some doctors and physiologists who denied the efficient influence of ozone to remedy unsanitary conditions or disinfect dwellings and purify the air, it is as Dr. Ohlmuller puts it, because the ozonisers were so small that they had no practical value.

Yield and Determination of Ozone.—It is very interesting to know how the experiments for the production and determination of ozone were conducted by the doctor of the Imperial Sanitary Board of Germany, which confirm the statements made by Dr. Fröhlich, assisted by Drs. Erlsvein Howe and Von Titzen Hennig.

His plant consisted of a 1 H.P. gas motor, a 65 volts 8 amperes dynamo, and an induction apparatus, about which we have no data. A Siemens ozoniser was used; before passing through the ozoniser, the air traversed a gas meter. Dr. Ohlmuller says that he obtained, with the expenditure of 1 H.P., 3 milligrammes of ozone per second (10 grammes, 8 per hour), with other apparatus a yield of 9 milligrammes could be reached. The quantity of ozone was

Time.	Ozone yield.	Time.	Ozone yield.
min. secs.	milligrammes.	mins. secs.	milligrammes.
0 42	5·8	1 48	15·2
0 42	6·2	0 54	11·3
0 45	6·4	2 0	11·5
0 48	6·3	0 18	13·0
1 0	7·7	0 26	15·1
0 15	10·2	3 12	16·5
0 18	10·8	0 36	20·9
0 22	9·9	0 46	25·8
0 24	10·0	4 15	25·8
0 30	12·4	6 45	30·7
0 36	11·6	7 0	36·2
0 39	10·2	...	...

Typhus bacilli in 500 ccm. sterilised liquor:

Time.	Ccm. of air.	One litre of air yield in ozone.	Ozone measured.	Germs in one ccm. solution.	Oxidation per 500 cc.
		mm.			
0	...		...	13,608,000	
2	3,200	6·3	20·2	8,391,000	67·5
5	7,800		49·1	2,154,600	
10	15,200		95·8	3,969,600	

Cholera bacilli, 100 cc. + 400 cc. distilled sterilised water:

0	...		...	1,020,000	
2	1,595	10·7	17·1	2,800	21·7
5	4,035		43·2	...	
10	7,985		85·4	900	

calculated by the Baumert method (*Poggendorff Ann.*, Vol. 84, p. 40). At the end of the ozone apparatus was adapted a glass tube pointed at its end, dipping perpendicularly in a cylinder containing a 5 per cent. solution of iodide of potassium. In order to ascertain the entire absorption of

ozone by the solution, a starched iodised paper was placed on the top of the cylinder; one litre of air was slowly forced into the liquid, and the test was made of iodine liberated, in 100 cc. of solution by means of a hyposulphite of sodium and bichromate of potassium solution. It was observed that as soon as ozone was in contact with the iodine solution, white clouds were formed over its surface.

The conclusion of the long report of Dr. Ohlmuller to the Imperial German Sanitary Board is worth knowing, and I wonder how in a country where sanitation is a motto, and where so many people pretend to be interested in sanitary reforms, such an important official paper has not been published by the Press and made known all over England.

"When summing up the results of these researches, we come to this conclusion: that ozone acts in a strong manner on bacteria floating in water, on this condition that the water is not too much contaminated by inanimate organic substances, the result is the same when the quantity of lifeless organic mass is oxidised up to a certain degree by ozone."

The solution of the problem of the cheap production of oxygen by electrolysis, and of its transformation into ozone, will change the economic laws and conditions of many manufacturing industries, and the more so as human ingenuity will certainly find other methods more perfect, to produce and also to work and apply ozone.

Look at the wonderful applications of modern electricity? Who knows what will be the future development of the ozone industry?

AN UNPUBLISHED LETTER OF THOMAS SPENCER.

The name of Thomas Spencer has almost passed from the memory of scientific men, yet half a century ago his work in electrotyping commanded the widest attention. His discoveries were the subject of a most remarkable controversy, and it was claimed by the late Mr. Henry Dircks that Jordan, and not Spencer, was the real discoverer of the electrotyping process. Be this as it may, no one denied to Spencer the importance of his work. The following characteristic letter was sent by him to Dr. Mohr, of Coblentz, to whose son, Dr. B. Mohr, we are indebted for the loan:—

Liverpool, *March 28th*, 1841.

My Dear Sir,—With this I beg to introduce to you my young friend, Mr. William Ratcliffe of this town, and on his way to the celebrated laboratory at Grissen, where he intends to remain for, I believe, two years; I know him to be an ardent and most promising student, and when I say this, I am sure it will ensure for him any little attentions he may require while passing through your good old town of Coblentz. I did expect to have seen you on your return from Scotland, but I suppose you took another route homewards. While in Glasgow you may remember I stated I have made some further progress in galvanism but had taken a patent for it. I can now give you a brief sketch of it. I first practised the discovery in June, 1840, and made application for the patent in August which was granted subsequently, after explaining to our legal authorities what the invention was. It consists in eroding, or cutting *into* metals, instead, as before, of depositing *on*, and what enhances the value of this application is, that the process is generally completed in an hour or two, according to the depth of line required; in some instances, indeed, it may be completed in a few minutes.

The process in every respect resembles etching with an acid, but with this *most essential difference*, that the beauty and depth of the line by far exceeds anything that could by possibility be produced by an acid, and, what is more, you have it most perfectly under control. I have subjected the whole of the useful metals to this process and have been successful beyond my most sanguine expectations, and more particularly with steel, the great desideratum of the present day being to get an immense number of impressions. I have already applied it in every species of engraving, and also in that for printing calicoes, and for earthenware and china. In these last species of art they were unable to get a line deep enough by an acid, and had always to employ the graver. All the metals require to have the process modified to suit with their combining powers, for instance, to cut lines into platinum or gold I employ a weak solution of any salt containing chlorine, as a solution of a nitrate or sulphate would not act on them.

When the lines are required to be particularly fine, I employ a neutral solution of a salt that contains an acid having but small affinity for the metal required to be acted on. As in the case of copper, I would prefer a solution containing an acetate or a sulphate, to a nitrate; and in like manner with the other metals. Steel also requires a peculiar modification of the process, as the carbon has to be acted on as well as the iron. In this latter I have been successful, as the specimen I enclose may sufficiently attest, it being an impression from a block of *hard* steel engraved in an hour by Voltaic electricity. I can accomplish now much finer, as this was done four months ago; but it must be borne in mind the lines were not drawn in that time, I speak only of the process of cutting them into the block. It would take more time than I can at present spare to describe to you all the minutiæ of the process; but it may be briefly done as follows:—

When desirous to engrave a subject on a metal plate, I give it a *thin* coating of wax or varnish while hot, and when cool and sufficiently dry, the design or drawing is made on the surface of the plate thus protected with a fine point, taking care that every line made shall expose the metal to be acted on. Thus far you will perceive the process is in every respect similar to the old one of etching with an acid.

The plate, being thus prepared, is now to be fastened to a wire and put in connection with the negative plate of a battery, say of a single pair of electromotive metals. Another, but unprepared plate, must in like manner be put into connection with the zinc plate of the battery. This completed, the two plates must be placed in a separate vessel containing a weak solution of a neutral salt.

To be plainer I subjoin a sketch of the arrangement:—

Fig. 1—the battery, A the negative plate, B the positive

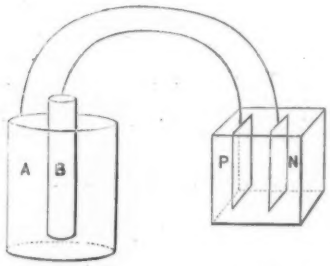

Fig. 1. Fig. 2.

one. Fig. 2—the second cell, containing the plate to be engraved and the unprepared one to be opposed to it, P being the prepared plate, in connection with the copper or platinum end of the battery, and N being the unprepared one in connection with the zinc end of the arrangement.

You will at once perceive what will of necessity take place; oxygen being liberated at P and hydrogen at N. Should the metals to be acted on be copper, and the interposing solution be a cupreous one, as the sulphate cu., the surface of the exposed lines of the prepared plate will combine with the oxygen and then be taken into solution, while on the other hand an *exactly* equivalent amount of metal will be deposited in the solid form on the opposite plate by the action of the nascent hydrogen. This process is to be continued until the lines are judged deep enough.

By a judicious regulation of the distance and *angle* of the opposing plate, any depth of tint may be acquired, and also by the particular part the wire is fastened to the prepared plate, as, in the event of the plate being required to have lines all of one depth and tint, this may be insured. Also, as in a landscape, should the foreground be required darker than the back or distance; also, should the centre be required deep, and the edges light—or, should the centre be light and the edges deep—in short, I know of no imaginable circumstance that may arise that may not be produced by judicious, and at the same time simple, management of this most beautiful principle.

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It also serves to engrave in the most beautiful manner the photogenic pictures of Daguerre. I have been also able to imitate wood engravings by it, that they may be printed from in relief.

There are a multitude of useful applications of this process that I cannot enumerate here. It may be asked where is the difference between this process and that attained by etching with an acid? It consists in this, an acid line on a copper plate, when viewed under the microscope, consists in a series of irregular cups, and whenever *depth* is required they become very much too wide, and it also requires very much attention as plates are often spoiled.

Hence its use for higher purposes is very much limited to outline, and where the lines are crossed they eat or corrode into one another; during the process also the bubbles require to be perpetually cleared away. Not one of these objections apply to the galvanic method; the lines when under the microscope present a perfect *canal*, just rough enough to hold the ink, and they may be a considerable depth without being too wide. When crossed the lines never run into one another, but preserve all their angles as perfect as when drawn, and no attention is required during the process.

How exquisitely your highly-gifted countryman Retzh might by this process produce his outline designs on steel, from which 20,000 impressions might be obtained.

I have spoken of myself only in this application of electricity, but it was made jointly and simultaneously by myself and my friend Mr. Wilson, both of us having our names enrolled in the patent. The working of it out has been left to me, although it would have been in much abler hands had my friend's time not been otherwise occupied. In operating on this principle during the last eight months, many very curious results have arisen, which, although not without interest in a practical sense, are yet of high importance in a philosophical one. When I have these practical portions fairly at work I may then have time to publish them.

I have not long read Dr. Liebig's work on agricultural chemistry. Should you see him soon, thank him in my humble name for the important gift he has made in it to science.

I am, my dear Sir,
Yours very truly,

To Dr. Mohr. (Signed) Thomas Spencer.

P.S.—You may make any use of the above you think proper; should you think fit to publish in any of your periodicals you are at liberty.

FACTS AND FIGURES ON ELECTROLYTIC CHLORINE AND SODA.

By EMILE ANDREOLI.

It is no less an authority than Dr. J. Hopkinson who has given his report on the electrolytic production of caustic soda and chlorine (Holland and Richardson's patents). Following Messrs. Leith, Tate, Liveing, Massey, Swinburne, and others, Dr. Hopkinson tells us the tale of woe which has been sung to all sorts of tunes by various lecturers and writers on electrolysis on the disintegration of the anodes. The action of chlorine and oxygen on carbon had, however been known for many years, and it is remarkable that an eminent electrician, such as Dr. J. Hopkinson, should be so impressed by the inspection of the anodes discovered by Messrs. Richardson and Holland.

"The difficulty," says Dr. J. Hopkinson, "was that the electrodes, which were used for anodes, at which the chlorine gas was liberated, speedily disintegrated, and no form of carbon which was readily prepared appeared to stand for a reasonable time. This difficulty appears to have been completely surmounted. Lumps of gas retort carbon of suitable size, but of *the roughest possible* form are taken, a slot is cut on each side of each lump, the lumps are laid closely together, and a bar of lead is cast through the slots. These electrodes, of course, present a very considerable surface, and are perfectly well adapted to act as anodes. They must be *very cheaply produced*, as there is no material to waste, except the carbon, and this gas retort carbon is a cheap product so long as it is used in the *rough lumps*, in which state it can be purchased. The labour, too, should be but a small charge."

As a matter of fact, these anodes are constructed exactly in the same manner as those which Le Sueur uses in his tanks. "They consist of pieces of ordinary retort carbon embedded in a mass of lead, through which electrical contact is obtained." (Messrs. Cross and Bevan's lecture, *Journal of the Society of Chemical Industry*, December 31st, 1892.)

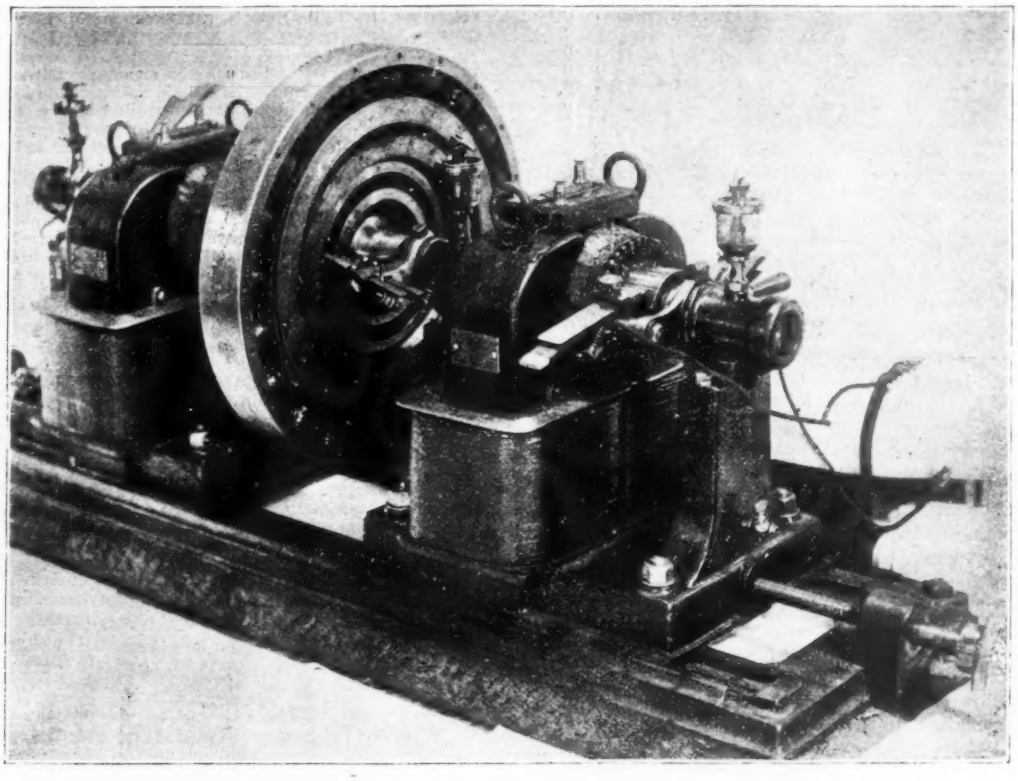
I will not say that this mode of construction of anodes is as old as the hills, but I will point out that before Messrs. Le Sueur, Richardson, and Holland, similar lead-carbon positive plates had been used by Gibson, of Edinburgh, who described in 1884 his employment of "carbon in lumps or fragments, which were held together at one end in a mass of metal or alloy, cast in the liquid state (*i.e.*, molten lead) around one end the said lumps or fragments, so as to hold them together, and in perfect electrical connection with each other." It may be a genial simplicity to take retort carbon pieces as they are, curved, crooked, as they seem to be, judging from a drawing published by a contemporary, representing the section of the Richardson and Holland tank, and to hang them in the electrolyte. Apparently this method is a very cheap one; but unless the carbons are completely immersed in the solution, they are cut and destroyed at the level of the liquid, and unless there is parallelism between the electrodes, there is no efficient yield. It is indeed very important in an electrolytic tank to dispose the anode, close and quite parallel to the cathode. What is true in the construction of secondary batteries is true also in the production of chlorine, and Dr. J. Hopkinson, who has recently devoted his time to the inspection and study of chloride of lead accumulators, the introduction of which in this country he recommends, would not have spoken well of them if their plates had been distorted, at unequal distances, instead of being parallel and side by side. So much for the anodes in the Richardson-Holland tank; there is nothing in that part of the report. The second part of this report, which I have read in the *World's Paper Trade Review*, refers to the electromotive force in the electrolyser; the third to the yield of chlorine and soda, and the fourth to the cost of the horse-power per annum. Dr. Hopkinson goes on to say that at the time at which he observed the process, about 500 ampères were passing through 13 tanks in series, and the potential at the terminals of the dynamo was nearly 80 volts. This gives a potential difference between the poles of each tank of about 6 volts. One could have expected that Dr. Hopkinson should make some strong remarks on this very unsatisfactory point. Le Sueur, Greenwood, and others require 4½ volts only, and there can be no mistake about the Richardson and Holland system, which requires 1½ volt more than the others. It is simply futile to say so much about the cheapness of the electrodes, when instead of 4½ volts, the Snodland electricians want 6 volts. Where is the progress? The real saving in electrolysis, as in many other operations, consists in effecting a maximum of work with a minimum of energy. In this case, it is evidently more costly to produce, *cæteris paribus*, 1 ton of soda and chlorine under a pressure of 6 volts than of 4½ volts, and it is unbusinesslike to pass carelessly on this weak point of the Richardson and Holland process. Can we not question the commercial value of an electrolytic method which takes nearly one-third more E.M.F. than the others? I like the *désinvolture* with which a contemporary says that "a pressure of 6 volts is somewhat high, but experience at Snodland has led to the adoption of that figure." I fancy the Snodland people adopted this figure, not under the influence of experience, but under the pressure of necessity. One must suffer for what cannot be helped.

(To be continued.)

Telephone Lines in India.—Transfer to the Telegraph Department, with effect from April 1st, 1893, of the telephone communications connected with the beach batteries, Madras, has been sanctioned on certain conditions by the Government of India; and the charges, amounting to Rs. 1,059-10-3, for the maintenance of the overhead and underground telephone lines till March 31st, 1893, are also sanctioned by that Government.

HIGHER FREQUENCY.

In the commercial transmission of alternating electric currents for light and power production at considerable distances from the generating point, a higher frequency of alternation than that usually employed would probably lead to so considerable a loss by reason of the capacity of the conductor and its apparent loss of conductivity owing to what is known as the "skin effect," as would more than counterbalance the gain which would be due to the increased efficiency of the transformers; however, though this may be the case, we should like to see more attention paid to the subject of our heading, as public distribution does not necessarily control or limit the whole sphere of electrical utility; for instance, where the quantity of current is not great and the distance to which it must be transmitted is inconsiderable, it might be desirable to use a higher frequency than the 5,000 or 6,000 ~ now so generally popular. This might, in many cases, be increased to 40,000 ~ with no other result than that of decreasing the size of the transformer necessary for conversion, this frequency not rendering the efficiency of the generator or distributing conductors appreciably smaller than with currents alternating at the frequency first mentioned.



Presumably, following on this train of thought, Mr. McClean, of Tunbridge Wells, commissioned Messrs. Pyke, Harris & Company, Limited, to construct to Mr. L. Pyke's design a continuous to alternating current transformer, furnishing current at a frequency of 40,000 ~ for use in his laboratory. We have pleasure in reproducing the photograph of the machine constructed to fulfil these requirements. The continuous current is taken from the house mains at a potential of 65 volts. The photograph hardly needs explanation, but to save any misconception it may be well to state that the machine consists of two continuous current motors driving in opposite directions the field and armature of the alternator, which is situated between them. The windings of the field and armature which are identical in electrical construction, consisting simply of reels of insulated wire surrounding iron wire cores, the sizes of wire on the two portions being different, so that as either one may be used for the field, one obtains a considerable range of E.M.F. other than that obtainable from a simple variation of the exciting current. The machine will thus furnish current at any E.M.F. desired, from a few volts up to 400 volts, which is that obtained when using the inner or long conductor set of bobbins as the armature, with a full exciting current in the outer set. Normally, the outer set of bobbins forming the armature, the inner, or field, taking current at the normal 65-volt potential of the mains, at an E.M.F. of 200 volts potential, sufficient current is produced to fully light 10 16-C.P. lamps. This is a result which, as far as we know, has never yet been obtained, the amount of alternating current energy furnished being proof that there can be no loss worth mentioning in the generating machine, very little more than this amount constituting the difference in consumption of continuous current with full or no load.

The continuous current is led in at two top terminals of the switchboard, and after passing through measuring instruments is distributed to the field and armature of each motor and to the field of the alternator by five pairs of terminals at the base. There is an adjustable platinoid resistance in each circuit, and the motor switches are arranged so that the field of each must be energised before current can be turned on to the armature. Either one motor can be used without the other if the field of the idle one is energised so as to lock the armature and its portion of the alternator in position. As including resistance in the field-circuit of either motor tends to increase its speed above the normal, or if included in the armature circuit to have the reverse effect, it will be seen that not only may the E.M.F. be varied while the speed remains constant in the manner before described, but also the frequency of alternation may be varied within very considerable limits.

Magnificent effects are obtainable with a small transformer constructed to take the whole output of the machine, and, also, with extremely small transformers, taking only a proportion of the whole current and each bearing an attached induction coil arrangement capable of forming some extremely beautiful illuminating devices; but as these will be dealt with shortly by us and illustrated, the description, which cannot satisfactorily be abridged, may well be reserved till then.

CUTTING DOWN PRICES.

WE called attention in last week's issue of the REVIEW to the extraordinarily low price at which the electric lighting of the Southampton Public Library had been undertaken by a Manchester firm. The estimates of three well known and experienced London firms were considerably in excess of £300; four others of equal repute, three hailing from the Metropolis, and the fourth from Birmingham, were above £250; four Southampton contractors required over £200, and yet the accepted tender was but £167. Now, how in the name of all that is wonderful can this installation be carried out in accordance with the specification at the price named? So as not to be accused of writing without a knowledge of the requirements, we asked for details of the work, and a copy of the specification was at once kindly forwarded to us by one of the competing firms. After a careful perusal we jotted down a few figures which seem reasonable enough, and we request that the firms who tendered will inform us whether they consider these err greatly on one side or the other with respect to the items which follow:—

	£	s.	d.
Dynamo, as specified, with spare armature ...	75	0	0
Switchboard	7	10	0
Lamps	12	10	0
Fixtures (at prices arranged)	28	18	0
Wiring	67	0	0
Cutting away and making good	5	10	0
Main cable from dynamo to switchboard ...	7	10	0
Fixing fittings	3	7	0
Link belt, fixing dynamo, including rail fares ...	10	10	0
Carriage, contingencies, superintendence ...	15	0	0
	£232	15	0

Probably exception will be taken to the estimate given above for wiring as being too low, and, as we have no means of judging the distance from dynamo to switchboard, the item for main cable, is, to an extent, guesswork. We feel sure, however, that the total will compare very nearly with the cost prices of the best firms, but we have not added any percentage on the whole sum in the way of profit.

What reasons, then, can be assigned for a firm at such a distance from Southampton sending in a tender nearly £50 less than the average of the four local firms, and something like £140 lower than the mean of ten metropolitan tenders?

Whether it is for the purpose of advertisement, for the sake of coming to the front as electrical contractors, or through sheer ignorance of the business, we cannot say, but we do not hesitate to express our belief that if the Manchester firm is held strictly to the terms of Mr. Aldridge's specification, the balance-sheet of that particular business will show heavily on the wrong side, and we think also that it would have been only kindly advice on the part of the consulting engineer to have asked the successful firm to reconsider its tender, for we assume that he is aware of the market prices of electrical appliances.

In how much the leading firms of electric light contractors are injured by the cutting down of prices below actual cost is a matter which is best known to themselves. If confined to small installations of infrequent occurrence perhaps the injury sustained is scarcely felt, but if the same thing obtains generally, it becomes then a subject for serious consideration.

LONDON CHAMBER OF COMMERCE.

THE annual meeting of the London Chamber of Commerce was held on Thursday last in the council room, Botolph House, Eastcheap, under the presidency of Sir John Lubbock, Bart., M.P. The report adopted by the meeting contained the following:—

"During the year the Electrical Trade Section has held three meetings, in addition to a considerable number of meetings of special committees appointed to deal with various subjects. One of the most important matters dealt with was the County Council bye-laws for the regulation of overhead wires under the Act of 1891. A special committee was appointed to take what action might seem necessary in regard to the bye-laws, and as a result a petition was prepared and sent to the president of the Board of Trade, pointing out the impracticable nature of many of the proposed bye-laws. This was followed up by a deputation to Sir Courtenay Boyle at the Board of Trade, and it is satisfactory to state that the bye-laws were ultimately settled to the general satisfaction of the industry. An attempt was made to organise a representative electrical exhibit for the Chicago Exhibition, but as the suggestion did not meet with sufficient support, the matter was allowed to drop. A special committee was also appointed to consider the possibility of reconciling the rival claims of the traction and telephone companies as to the 'use of earth.' A number of gentlemen were appointed arbitrators to act in the settlement of any disputes arising in the trade under the rules and regulations of the London Chamber of Arbitration. The section has agreed to follow the precedent of other sections by abolishing its standing committee, and convening the whole of the membership to all future meetings. Other questions discussed included the relation of the Association for the protection of telephone subscribers to the chamber, electrical communication on the coasts, merchandise marks, standardising of electrical machinery and uniformity of prices."

INFLUENCE OF THE FREQUENCY ON THE PHYSIOLOGICAL EFFECTS OF ALTERNATING CURRENTS.

NOTE BY M. D'ARSONVAL, PRESENTED BY M. BOUCHARD.

AN electric flow passing through the organism excites the nerves and muscles simply by its variation. In a former note I have shown the means of obtaining by synthesis the electric wave representing this variation.* After having studied the physiological effects of a single wave of a known form, I was naturally led to the observations of periodic waves. These systematic researches, pursued since 1881, brought me some results which I give in the few notes summed up in the present communication.† To study the influence of the frequency of the excitations, I employed a very simple alternator, without iron, the principle of which was conceived by M. Gramme in 1870, and which is capable of giving as many as 10,000 alternations per second. The currents produced were sent into the primary of a du Bois Reymond apparatus, without iron, which would enable the excitation to be regulated by drawing back the bobbins so as to preserve the same intensity.

With low frequencies there is neither pain nor muscular contraction, but this current acts powerfully on the nutritive organs by increasing the absorption of oxygen and the elimination of carbonic acid. It is very effective in allaying pain, and these valuable properties are now turned to account by various medical men under my instructions.‡

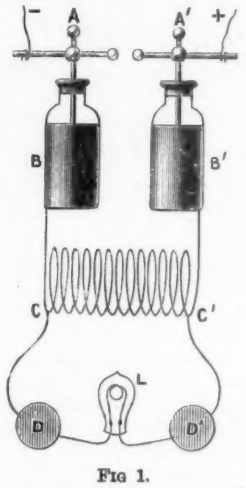


FIG 1.

By increasing the frequency the excitation appears, but the current is borne better and better, *with an equal intensity*, starting from 2,500 to 3,000 alternations per second, these figures seeming to indicate the greatest excitation. In order to exceed 10,000 excitations per second, I used, in December, 1890, Dr. Hertz's vibrator, which enables enormous frequencies to be obtained, exceeding several millions per second.

I could then show, in my public lectures at the Collège de France,

* See *Comptes Rendus*, March 25th, 1891.

† See *Comptes Rendus de la Société de Biologie*, April 1st, 1882, February 24th and April 25th, 1891; Conferences held at the Société des Electriciens and at the Société de Physique, April, 1892; *Archives de Physiologie*, 1889, and following years; *Comptes Rendus*, June 27th, 1892.

‡ See the publications of M. Apostoli and those of Messrs. Gautier and Larat (Académie des Sciences, Société d'électrothérapie and Société de Biologie, 1892).

the surprising fact that when the number of excitations is very considerable the phenomena of excitation of the nerves and muscles are no longer produced. This fact was also communicated to the Société de Biologie, February 24th and April 25th, 1891, consequently before its publication at New York, May 25th, 1891, by M. Tesla. Hertz's vibrator, giving somewhat feeble currents, I substituted for it the apparatus proposed by Elihu Thomson a year later, which apparatus I now replace by the following, derived from Mr. Elihu Thomson's experiments and from those of Dr. Lodge.

Two Leyden jars are mounted in cascade (fig. 1), their interior armatures, A A′, communicating with the poles of a strong Rhumkorff coil, the exterior armatures, B B′, are connected by a solenoid, C C′, consisting of a thick copper wire making from 10 to 15 turns. Taking the extremities, C C′, of the solenoid as poles, we obtain sparks much longer than those at A A′, and an extremely powerful oscillating current. This current can bring to white heat an incandescence lamp absorbing 1 ampère, and held between two persons, D D, completing the circuit. Substituting an alternator for the bobbin, I caused currents of more than 3 ampères to pass through my body without experiencing any other effect than a feeling of heat at the level of the hands.* If we wish to increase the length of spark, we introduce into the solenoid a fine wire bobbin with a greater number of turns, and enclosed in a glass cylinder filled with mineral oil, as shown in fig. 2.

The current emanating from C C′ may be employed in two ways, either we send it directly into the tissues to be electrified, and graduate its intensity by taking a varying number of spirals, or we

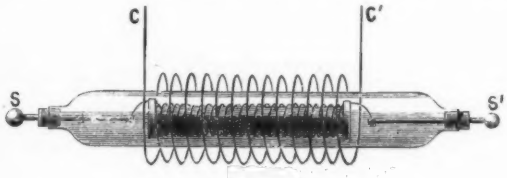


FIG. 2.

cause it to circulate round the body to be electrified, which is then plunged into the solenoid. In this latter case the body to be electrified is traversed by induced currents, which are very powerful by reason of their frequency, and it acts as a conductor closed upon itself. The phenomena which I observed in the first case may be summed up thus:—1. No effect on the sensibility and contractility. 2. The production of analgesia at the points of application of the electrodes. 3. General vascular dilatation accompanied by a fall of the sanguine pressure and by the production of perspiration. 4. An augmentation of organic combustion without any elevation of the central temperature, but with a greater loss of caloric at the periphery, as shown by the calorimeter.

These experiments confirm the opinion which I have maintained, that the sensitive and motive nerves, like the acoustic and optic nerves, are adapted to certain determined vibratory periods. Like these, they do not respond to undulations, the frequency of which is too low or too high. This is a fresh instance of the phenomena of inhibition to which M. Brown-Séquard has called the attention of physiologists. These results, which are due to the alliance of physics and biology, open up a new and fruitful field in therapeutics, as I shall show in another paper.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

NOTES ON THE INFLUENCE OF ELECTRICITY IN TANNING OPERATIONS. By CONRAD K. FALKENSTEIN, Associate.

(*Concluded from page* 462.)

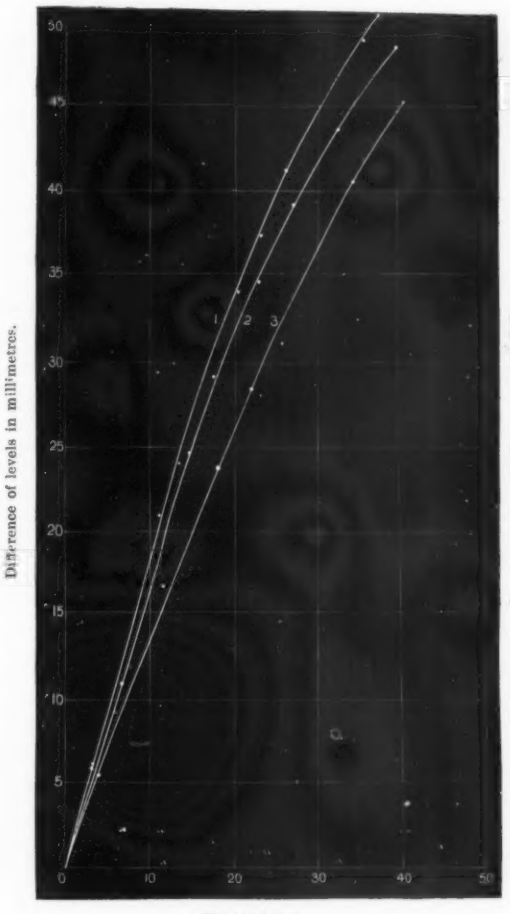
TABLE B.—CURVES Γ_1 AND B_2.

Percentage of tannin.	Volts.	Mean current.	Rate of flow.	Proportional rate of flow.	Proportional current.
1	9·0	0·0066 amp.	1·22	1·00	1·00
2	9·0	0·0079 „	1·60	1 31	1·19
3	9·0	0·0109 „	1·80	1·47	1·65

* In explanation of the harmlessness of these high intensities, it has been said that the high frequency current which brings these lamps to white heat is incomparably feebler than that which they absorb under ordinary conditions. This explanation is erroneous, as I can show by the following experiment: I bring to red heat with the high frequency current a thin platinum wire, I plunge it into a vessel containing pretroleum and note the elevation of temperature corresponding to the passage of the current during five minutes, for instance. I recommence the experiment, bringing the wire to the same temperature with a continuous current, and I find that the heating of the petroleum (and consequently the effective intensity) is the same in both cases. Mr. A. Campbell Swinton, who is now repeating in London, on a smaller scale, the experiments which I performed last Easter before the Physical Society, admits this explanation.

From the above it will be seen that the rate of flow (as measured by tangent to curve) increases with the strength of the liquor.

This fact is specially important for the following reason: In ordinary tanning operations it is well known that the greater portion of the gelatine is combined in the first month or so of the tannage,

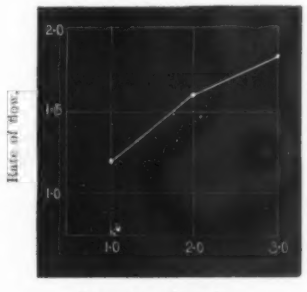


Time in hours.

1,—3 per cent. solution of tannic acid; 2,—2 per cent. solution of tannic acid; 3,—1 per cent. solution of tannic acid.

CURVES B_1.—POTENTIAL DIFFERENCE = 9·0 VOLTS.

the remainder of the time being spent in tanning the middle layers and giving weight, owing to the increased resistance which the outer tanned portions offer to diffusion. Now, for reasons given earlier in the paper, it is necessary to use liquors of gradually increasing strength as the tannage proceeds, and which, for any given potential difference, give (as shown in curve B_2) an increasing hydrostatic



Percentage of tannin.

CURVE B_2.

pressure or head tending to force the liquor through the hide; thus there is a kind of self-regulating arrangement, viz.:—as the mechanical resistance of the hide increases, so the endosmotic pressure increases to overcome that resistance.

The next experiments were made, using diaphragms of different materials and keeping potential difference and strength of liquor constant, the results being shown in Table C:—

TABLE C.—CURVES C.

9 volts. 1 per cent. solution of Oakwood tannin.

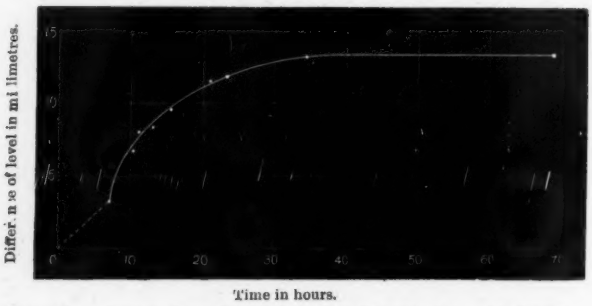
Diaphragm.	Mean current.	Rate of flow.	Proportional current.	Proportional flow.
Struck sole	0·0041 *a*	0·20	0·62	0·16
Porous clay	0·0066 „	1·22	1·00	1·00
Dressing hide ...	0·0106 „	1·58	1·60	1·29

In the above will be noticed the great difference in mechanical resistance to diffusion between leather, before and after it has been struck (*i.e.*, smoothed down and worked over with the striking pin) and rolled. The curious bending over of the curve for unstruck hide is due to the influence of the head of liquor and openness of the pores allowing the liquor to run back again, a certain point being reached, at which this leakage becomes equal to the flow, and the difference of levels remains constant. This effect is also shown in curve D with tap water and a porous clay diaphragm.

Time in hours.

1, Porous clay; 2, unstruck hide (dressing); 3, struck hide (sole).

CURVES C.—1 PER CENT. SOLUTION OF TANNIC ACID P.D. = 9·0 VOLTS.



Time in hours.

CURVE D.—POROUS CLAY DIAPHRAGM (TAP WATER) P.D. = 7·2 VOLTS.

The next experiments were made, using liquors prepared from different tanning materials, and keeping the potential difference constant and using the same porous clay diaphragm, the results being shown below:—

TABLE E.—CURVES E.

9 volts. 1 per cent. Solutions.

Liquor.	Mean current.	Rate of flow.	Proportional current.	Proportional flow.
Distilled water ...	0·00078	0·095	0·12	0·077
Shumac	0·0204	0·97	3·09	0·79
Oakwood extract ...	0·0066	1·22	1·00	1·00
Oak bark	0·0164	2·02	2·48	1·65

In the above curves 10 mm. difference of levels corresponds to 11·36 cc. passing through the diaphragm, the levels in both compartments being the same on starting experiment.

II. AND III.—CHEMICAL ACTION.

II.—To compare the precipitation of anhydride, &c., in solutions of tannic acid, when a current is passed through them, and when allowed to remain during the same time and under the same conditions, but without passing a current.

III.—To determine the amount of tannin in the liquor before and after passing an electric current.

In carrying out the above, two beakers were taken, in each of which 150 cc. of tan liquor (containing 5 per cent. oakwood tannin) was placed. Through the liquor in one beaker a current of 0·0086 ampère (measured by voltameter) was passed for 96½ hours, and the other was allowed to stand open by its side, being thus under exactly the same conditions, excepting that it had no electricity passed through it.

No.	Description of liquor.	10 cc. infusion.	10 cc., after hide powder.	cc. of non-tannin.	Tannin per cent.	Non-tannin per cent.
I.	Liquor before experiment	32·75	19·5	1·9	5·007	0·69
		32·70	19·4	1·8		
II.	After exposure, without passing electric current	32·50	19·55	1·95	4·88	0·72
		32·45	19·50	1·9		
III.	No. II., filtered ...	32·15	19·45	1·85	4·79	0·69
		32·15	19·45	1·85		
IV.	After passage of an electric current and exposure	32·5	19·0	1·4	5·073	0·54
		32·5	19·1	1·5		
V.	No. IV., filtered ...	31·0	18·9	1·3	4·57	0·48
		31·0	18·85	1·25		

In the above analyses:

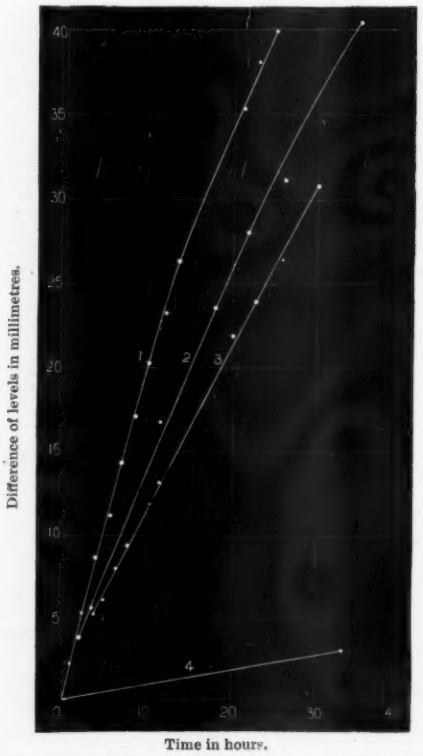
33·4 cc. of permanganate = 10 cc. $\frac{n}{10}$ crystallised oxalic acid.

17·6 „ „ = 20 cc. indigo carmine.

The same solutions were used throughout the above experiments; 10 cc. of a diluted solution ($\frac{1}{10}$th) were titrated with permanganate in presence of indigo carmine before and after treatment with hide powder. On examining the above results we may notice:—

(1) The action of the electric current on bodies which are absorbable by hide powder.

(2) The action of the electric current on bodies which are not absorbable by hide powder.



Time in hours.

1.—½ per cent. solution of oak bark tannin; 2,—1 per cent. solution of oakwood ext. tannin; 3,—1 per cent. of shumac tannin; 4,—distilled water.

CURVES E.

(1) On comparing Nos. I. and IV. it will be seen that the total amount of tannin remains unaltered, or, if anything, to have slightly increased after the passage of the current. On filtering IV. and again analysing, it will be seen that some of the tannin has been precipitated (see V.), probably as anhydride or phlobaphene. This precipitate, as seen from the experiment with the three-compartment cell, is produced at the cathode by the action of the hydrogen evolved there; this tannin is proved by column IV. to be still available for tanning purposes (after heating).

(2) This action is very marked, as will be seen from examination of columns 5 and 7 in table, the number of cc. of permanganate consumed by these non-tannin bodies goes down from 3·7 in the original liquor to 2·9 in the unfiltered electrolysed solution, and to 2·55 in the filtered; this reduction is really greater than is apparent here, because the electrolysed solution was exposed to the air for exactly the same time as the other, and therefore the increase of 0·15 cc. produced by exposure in the non-electrolysed should be added. This leads one to think that there may be a kind of restoration of the liquor, the tannin which has been decomposed by exposure to the air being reduced, possibly by the nascent hydrogen at the cathode; this would account for the reduction in the quantity of non-tannin matters, although, if these were more easily oxidisable than the tannin, the oxygen evolved at the anode might influence this result.

Summary.—The principal chemical actions of the current on tan liquor, using platinum electrodes at a current density of 1·6 ampères per square foot, are:—

1. Precipitation of anhydride of tannin; this precipitate is more copious with a tannin capable of yielding "bloom," as shumac, in which case the electrical conductivity is higher (see Table E).

2. Reduction of the amount of non-tannin matters in the solution. The above shows that, at all events below current densities of 1·6 ampères per square foot, a limit which is never exceeded or reached in practice, there is no loss of tannin due to the action of the electric current, as the ratio $\left(\frac{\text{number of ampère-hours}}{\text{number of cc. of liquor}}\right)$ in this experiment is considerably greater than that employed in practice—say 366 : 1. I have found that the solubility of the precipitate decreases as the current density increases.

There is an effect (referred to earlier in the paper) which doubtless influences the rapidity at which the gelatine and tannin combine, viz., the molecular vibration of the liquid and hides, due to the phenomenon of electricity being a vibration of the ether, agitating the particles and making them combine with their affinities sooner than they would do if left to themselves. In support of this, the fact of tanning operations being accelerated by rise of temperature may be brought forward, heat being a similar vibration of the ether, differing only in period from the electrical vibration.

In endosmose, however, we have a perfectly tangible, measurable effect, propelling the liquor in the direction of the lines of current flow, tan liquor also being a particularly favourable medium for this purpose, for the following reasons:—

1. The force increases with the percentage of tannic acid in the solution, thus falling in with the practical methods of tanning, *i.e.*, increasing as the permeability decreases.

2. The electrical resistance of tan liquor being high, the necessary difference of potentials (to the square of which the endosmotic flow is proportional) can be obtained between adjacent portions of the liquid without an undue expenditure of current, and therefore of energy.

We might approximately calculate how much tannin would be likely to pass through a 20 lb. butt (tanned and dry wt.) in an hour, using, say, a 12 ampère current at 9 volts, with proportionally larger electrodes, but keeping the distance between electrodes and hide the same as in experiment C, with unstruck hide (it must be remembered that the leather in question was fully tanned, and therefore its permeability was at its minimum value).

Area of butt = 54″ × 66″ = 3,564 square inches.

Working area of diaphragm = 2⅜ square inches.

$$\text{Tangent to curve near origin} = \frac{10 \text{ mm.}}{6{\cdot}3 \text{ hours}} = \frac{11{\cdot}36}{6{\cdot}3} \text{ cc. per hour.}$$

Current in experiment = 0·0106 ampère.

One gallon = 4,536 cc.

Increasing the current to 12 ampères, and assuming (from Table A and curve A_2) that the flow is proportional to the current, we have

$$\frac{11{\cdot}36 \times 12}{6{\cdot}3 \times 0{\cdot}0106 \times 4{,}536} = 0{\cdot}45 \text{ gallon of liquor passing through the butt per hour;}$$

this, supposing the liquor to contain 4 per cent. of tannin, and to have a specific gravity of 1·02, would be equivalent to

$$\frac{0{\cdot}45 \times 10 \times 1{\cdot}02 \times 4}{100} = 0{\cdot}1836 \text{ lbs. of tannin.}$$

If the butt require $20 \times 0{\cdot}45 = 9$ lbs. tannin to tan it, then this amount would pass through in 49 hours. From the above it will be seen that, having a means of bringing the liquor into intimate contact with the fibres of the hide, and also of assisting it to combine whilst passing through, we are in a much more favourable position than when working with only diffusion and capillary attraction to bring the liquor to the interior and replenish it when exhausted, especially as the tannage proceeds, and the hide becomes less and less permeable.

In conclusion, I must express my thanks to the British Tanning Company, Limited, for facilities granted in carrying out experiments, and permission to publish results.

Some Applications of Electricity to Chemistry.* By James Swinburne.

II.

The electrolysis of fused salts has not been studied nearly so thoroughly, either from theoretical or practical points of view, as of the aqueous solutions of the same compounds. There are many reasons for this, the chief being the inconvenience of having to work at high temperatures. Though many of the salts appear to fuse easily, that is to say, at low temperatures, it will generally be found that they contain water of crystallisation in which they melt, and that the anhydrous salts need something approaching red heat. It is not easy to work with substances which are red or white hot Again, many of the salts volatilise at temperatures close to their fusing points, and on the small scale necessary for laboratory work it is troublesome to regulate such temperatures with any accuracy. Nevertheless, the electrolysis of fused salts is of enormous importance. The production of caustic soda and bleaching powder by the electrolysis of a solution of salt has been discussed in the previous lecture; the electrolysis of fused salt is a much more tempting process. Chlorine is given off at one pole, and there is no trouble from formation of hypochlorites. At the other pole sodium comes off in vapour. Sodium, it need hardly be mentioned, is very much more valuable than caustic soda. It is largely employed for reducing aluminium from its chloride by substitution. In addition to that, however, it would provide a means of obtaining pure caustic, as all that has to be done is to allow water to act upon it. This would mean saving in packing and carriage. Many attempts have been made to produce sodium from fused common salt on a large scale, but, so far, the process does not seem to be satisfactory. Sodium is produced, but it is difficult to collect it well, as it comes off mixed with a great deal of vapour of salt. Then there is trouble with the anodes; any metal is attacked, as chlorine, of course, attacks a red hot metal. Carbon also seems unable to stand. There is still another difficulty. Salt volatilises at a temperature not very much above its fusing point, and distils over with the sodium. In addition to this, hot sodium attacks silicates, so that it is difficult to collect it.

Common salt may be taken as typical, as its electrolysis shows most of the difficulties as well as most of the advantages of working with a fused electrolyte. In the first place, when a solution is used the electrolyte contains oxygen, and the result of this is, that there is difficulty in reducing metals that have a strong affinity for oxygen —such, for instance, as sodium or aluminium. Water, of course, contains oxygen, and so does alcohol. Glycerine, which is a much more universal solvent than is generally known, also contains oxygen. Alcohol, which dissolves many metallic salts, such as nitrates, is unavailable for the same reason; and liquids like the hydro-carbons, which contain no oxygen, do not dissolve salts, and are not conductors of electricity. If fused salts are employed, however, the difficulty is overcome. The various metallic chlorides are mostly easily fusible, and so are many fluorides and cyanides. By employing their fused chlorides, strontium, magnesium, calcium, aluminium and barium may be reduced electrically. Most chlorides can be prepared easily by dissolving the oxide in hydrochloric acid, and evaporating down. This process cannot be applied in the cases of magnesium or aluminium, as the metals have such an affinity for oxygen that hydrochloric acid is given off, and the oxides, and not the chlorides, are left behind. There is an interesting point to be mentioned in connection with the electrolysis of fused sodium and potassium chloride; the yield of metal is said to be considerably below the theoretical value. It has been suggested that this is due to the formation of a sub-chloride. This suggestion is probably wrong; but it is worthy of careful investigation, as, if it is true, sodium and potassium cannot be monovalent metals. It has been suggested on quite other grounds that they are trivalent, which would, of course, make two more chlorides possible. Another curious phenomenon is that many fused salts appear as if they conducted without any decomposition—that is to say, they seem to act like metals. This also seems impossible. It would mean that fused electrolytes were an exception to the rule that all transparent liquids which conduct do so electrolytically. All transparent solids are, of course, non-conductors of electricity. It must be remembered that the distinction between fused and ordinary electrolytes is purely arbitrary, depending on the temperature at which we happen to live. If we were beings living at a temperature a few hundred degrees higher than the world is at present, we would regard water as gas and salt as a liquid, and Prof. Dewar would be freezing salt into the form they now know of, and liquefying water under great pressure. It seems unlikely that any extraordinary action, such as non-electrolytic conduction, should take place in the case of a fused iodide; it is more probable that these salts are good solvents, and that the products of electrolysis dissolve and are carried over to the opposite electrodes. Potassium, sodium, lithium, strontium, magnesium, barium, calcium, and aluminium can be easily reduced from their fused anhydrous haloid salts. Tungsten can be obtained from fused sodium tungstate, and boron from melted borax.

The chief industrial application of the electrolysis of fused salts is in the production of aluminium. One of the forms in which aluminium occurs in nature is a double fluoride of aluminium and sodium, cryolite. This ore is fairly plentiful, and was for a long time employed in Germany as a source of sodium in soda manufacture. The cryolite is fused and electrolysed in an iron vessel. This is kept hot, and the cryolite is kept in a molten state by the heat produced by the passage of an enormous current against the resistance of the electrolyte. The oxide of aluminium, or alumina, is in many cases dissolved in the cryolite also. Salt is frequently added to reduce the melting point, so that a lower temperature will serve. The electrical power is taken from large dynamos driven by water power.

It is not impossible that great things will come from fused salts in the future. One of the greatest problems of the age is to obtain power more economically from coal. The boiler and steam engine is not an economical arrangement, and many workers have tried to use carbons as the burning plate in a primary battery. Carbon has little affinity for oxygen at ordinary temperatures, but when it is hot it is possible to get a current with carbon as the positive element.

When an electrolyte is subjected to an electric current a transference of the radicles takes place, or, as it is generally put, there is a migration of the ions. If a solution of chloride of copper were electrolysed, and if there were no movement of the chlorine and copper during electrolysis, all the chlorine in the immediate neigh-

* A course of three "Tyndall" lectures at the Royal Institution.

bourhood of the anode would be used up, and the water would be called upon to give up oxygen. At the cathodes, on the other hand, a little copper would be produced, but as soon as the salt in contact with the electrode was exhausted, hydrogen would be evolved. The result would be that with, say, a 20 per cent. solution of the salt only a fifth of the chlorine and copper corresponding to the quantity of electricity passed would be produced, the rest being spent on decomposing the water. The solution would, in fact, be decomposed just in the proportions in which it came in contact with the electrodes. It is because the radicles change places and move in opposite directions that a continuous supply of chlorine and copper is produced. It is as if the chloride of copper were made up of molecules, each consisting of an atom of chlorine and an atom of copper; the atoms of chlorine and copper keep changing partners in such a way that the chlorine moves towards the anode, and the copper in the opposite direction. To use a homely simile, it is like the "ladies' chain," in which the ladies go in one direction and the men in the other, but they are nearly always in pairs all the same. This transference is made available in electric tanning. It takes a long time to tan a thick hide, because the tanning solution penetrates the skin very slowly, because the cells of which it is built are impervious. Mechanical agitation will force the liquid into the interstices of the hide, but no farther; it cannot force the liquor through the walls of the cells. The passage of electricity, however, causes the tannin to pass through the walls of the cells also. It thus comes about that mechanical agitation alone does not accelerate tanning much, and electricity alone is also of little use, for the movement of the radicles is exceedingly slow. The combination is most effective, however, as the agitation brings the liquor into contact with the cells, and the electrical action drives it through the walls. The action of electrical tanning has been investigated by Dr. Rideal and Mr. Trotter, and it was during a discussion on a paper of theirs that the lecturer suggested the explanation here given, and Mr. Falkenstein is doing further work on the same very obscure, but interesting and important, subject. It has been proposed to utilise electric osmosis in various other ways, but so far without any important results.

Experiments were made showing the reduction of sodium, calcium, antimony, tin and lithium, from their fused chlorides. Fused glass was shown to be a conductor, and the local heating at the electrodes was shown.

LEGAL.

In the Queen's Bench Division, London, on Monday, the case of White *v.* Tussaud came before Mr. Justice Cave and a special jury. The plaintiff, an electrical lighting contractor, carrying on business at Mills Street, Regent Street, sought to recover £762 16s. as balance of an account of £1,072 14s. due from Mr. Louis Tussaud, the proprietor of the famous gallery of waxworks. The defendant resisted the claim on several grounds.

Mr. J. G. Witt, Q.C., and Mr. Rose Innes were counsel for the plaintiff; Mr. Tindal Atkinson, Q.C., Mr. Chitty, and Mr. Ernest Pollock were for the defendant.

Mr. Witt, in opening, said £699 was claimed in respect of 466 electric lights supplied at 30s. per light, and £373 16s. was for extra work done, the claim amounting altogether to £1,072 14s. There was a payment of £310 to be credited, leaving a balance of £762 16s. The defendant, who was in partnership with a gentleman named De Pinner, decided to have an electric installation in his gallery, and in October, 1890, applied to the plaintiff for an estimate. An estimate of the plaintiff to do certain work for £400 was accepted in November, 1890. While the work was in progress, it was suggested that the system was wrong, and there was danger of fire. A person named Hart, who was fixing scenery, said the light would not show off the scenery properly, and the defendant then ordered the plaintiff to fix the lights and do the work in a manner desired by Hart. The plaintiff accordingly followed the directions of Mr. Hart. The defendant and his partner were very anxious that the work should be finished by Christmas, 1890, so that their exhibition could open on Boxing Night, and by working night and day the plaintiff finished in time. All this work was on the first floor. At a subsequent date the defendant got the plaintiff to light up the basement, and this was the extras in the claim. In resisting the action the defendant denied that the work was done and materials supplied as alleged. He denied that he agreed to pay 30s. a light, and also said there was a special agreement that the work should be done so as to satisfy the fire insurance company, and that the work was not done in a workmanlike manner, and not by the time agreed. The learned counsel said there was a fire at the exhibition on June 19th, 1891, and when the defendant claimed against the Phœnix Insurance Company for his loss, he put in the whole of the money now claimed by the plaintiff for the lighting, and not only that, but stuck something on to it (Laughter.) On the arbitration between Mr. Tussaud and the Insurance Company, the plaintiff was called as a witness.

Mr. Thomas Maxland White, the plaintiff, of 9 and 11, Mill Street, Regent Street, gave evidence substantially corroborating his counsel's statement.

The foreman and other workmen of the plaintiff were also called.

Mr. Tindal Atkinson, for the defence, said the contract of November was entirely superseded by a fresh contract of April 17th following, and submitted that there was no case to go to the jury.

Mr. Justice Cave declined to stop the case at that stage.

Mr. Atkinson, addressing the jury, said the plaintiff was prevented carrying out the work under the agreement of November by a fire which took place, and by Boxing Day he had only got the wires in for certain lamps. The plaintiff had not called a single independent witness, but his workmen had had the face to swear that 466 lamps were in their places and ready for switching on and lighting at a moment's notice. But, excepting 70 lamps in the big dome, which were put up in November, by April 17th there was not a single lamp in any one of the groups or tableaux. Mr. Tussaud did not become the sole proprietor of the waxworks until March 25th. The correspondence and the documents gave the lie direct to the plaintiff's statement that by Christmas 466 lamps were ready to be lit the moment the switch went on. The agreement of April 17th contemplated the work being commenced then, and was based on the work in the main building being incomplete. The plaintiff wrote at this time: "As you are aware, I have not yet fixed all the incandescent lamps nor the arc lamps. I shall be ready to commence the work at once." Of the 466 lamps, plaintiff said 272 were fitted by April 17th, but under the agreement of that date he was only to receive £36 for the lamps already fixed. All that had been done by the plaintiff was unnecessarily to wire the building for a greater number of lamps than would ever be required. From the date of the agreement to June, 1891, when the fire took place in this building, not one single stroke of work was done by the plaintiff. The defendant kept pressing the plaintiff to go on with the work, and threatened to sue him for breach of contract. The plaintiff absolutely neglected the work, and never completed it.

Mr. Louis Tussaud, the defendant, said he became, in March, 1891, sole owner of the Waxwork Exhibition. Before that time the arrangements with the plaintiff had been made with Mr. de Pinner. On April 17th there were 70 dummy lamps in the dome, and a good number of wires and mains laid, but none of the lights for the tableaux were fixed. Witness sent for Mr. White, and had a long conversation with reference to the supply of lights. He told Mr. White that things could not go on as they had been doing, and new terms were arranged. For the wires already laid the defendant agreed to take £36, and he subsequently proceeded to the basement and fixed 62 lights. At the time of the fire in June, the plaintiff had not added a single lamp to the 70 that were in the dome. It was not true that the work of fixing the lights was interfered with by alterations to the building. The plaintiff had been overpaid for the value of the work actually done.

The hearing was resumed on Thursday.

Mr. Witt said, after making certain deductions and giving credit for £300, the plaintiff was entitled to £583.

Mr. Justice Cave having summed up, the jury gave judgment for the plaintiff for £583 with costs.

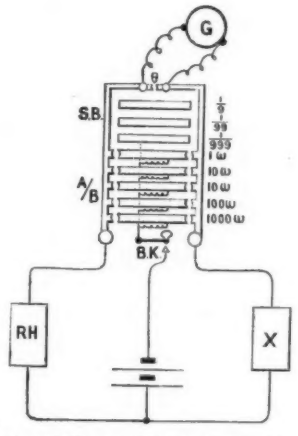
THE PARKS MODIFICATION OF A PROPORTIONAL WHEATSTONE'S BRIDGE.

In a recent number of the *Western Electrician*, of Chicago, U.S.A., there appears a short description of a modification in the arrangement of a Wheatstone's bridge which is of some interest. The designer of this pattern of bridge is a Mr. Parks, and he has evidently had some experience with bridges as turned out by American manufacturers, for it is not very difficult to see the points which are gained, and therefore to deduce the causes of the troubles which have led this experimenter to put forward a design free from the difficulties with which he himself most probably had to contend.

Some of the bridges we have seen which owed their birth to American hands, are delightfully naïve attempts to produce copies of our leading English patterns without, at the same time, the knowledge and handicraft skill which alone could enable such an attempt to be crowned with success. Leaving the question of finish alone and confining one's criticisms to the adjustment of the coils of such reproductions, there is great room for improvement in the accuracy with which, so far, the larger number of the bridges used on commercial work are endowed. By this, of course, it is not suggested that the accuracy should be brought to the limits desirable with the highest class of instruments for laboratory or submarine cable work, but more particularly the ratio coils should be reasonably close to what they are represented to be. This is the point gained by the pattern advocated by Mr. Parks, and although in this country somewhat similar boxes are listed in the catalogues of our leading instrument-making firms, we cannot recall a publication of the device used, or any work in which the advantages are recognised. Proportional arm bridges requiring a rheostat or box of fixed known resistances have been designed by Mr. W. H. Preece, Mr. Latimer Clarke and others, but from the few to be seen in use, do not appear to have been largely adopted or to take with those requiring to make measurements, probably owing to the trouble involved in the transport of a separate set of known coils in addition to the bridge proper, as against the compactness obtained, say, by a P.O. pattern box, in which all necessary parts are available and in reduced space. The modification we now have to notice is of the bridge type, and does not itself contain the arm of the Wheatstone lozenge which is balanced against the unknown. In addition

to the bridge there is a shunt box of the usual ratios, viz:—$\frac{1}{9}$th, $\frac{1}{99}$th $\frac{1}{999}$th G., mounted upon the same slab as the proportional coils, of which there is only one set.

The coils have values respectively of 1, 10, 10, 100, 1,000 and 10,000 ohms; the object of the double sets of the 10 ohm value being to enable "even bridges" or 1 to 1 ratio to be used when advantageous.



An additional coil of 10,000 ω is added if desired, making sixth coil to give five ratios.

Parks Modified Bridge.

The coils are connected at one end to the terminal block to which the battery is joined through the battery key, while the other is taken to blocks marked respectively with the resistances of the coils, and situated between two parallel bars, to either of which any one or other of the coils may be coupled up by means of a taper plug in the ordinary way. Owing to this, only one coil of the units, hundreds, thousands and tens of thousands range is necessary, and two of the tens, which can readily be interposed to correct any slight inequality in their adjustment. The cost should be reduced, as the number of coils is only about half those necessary in the English pattern and any slight want of balance can readily be allowed for. As will be seen from the cut, each coil can be used on either side of the bridge; this permits the use of only two plugs, whereas one of the ordinary P.O. pattern would have eight coils and eight plugs, replaced by four coils and two plugs, or, at the most, five coils, if even bridges be allowed for. Were this combined with the R. arm coils in a neat form, a handy set would result and one which for a given percentage accuracy should be rather cheaper than existing makes and, therefore, open to those who at present look upon testing sets as unnecessary luxuries.

NOTES.

Calcutta Electric Lighting.—We cull the following note from the columns of our contemporary, *Indian Engineering*:—"As in a great many other schemes for the improvement of the town, Bombay is far ahead of Calcutta in the matter of electric lighting. While we (Calcutta) are satisfied with a hole-and-corner house for the location of our municipality, the capital of the Western Presidency has erected, at a fabulous cost, municipal buildings which would be an ornament to any city in the world. These are now lighted throughout by means of electricity."

New Method of Aluminium Plating.—It is claimed that the drawbacks attending the inability of gilding and plating on aluminium have been entirely removed by the invention of Dr. Gg. Lehnert. By means of his method, aluminium may now be gilded and plated either by galvanic deposit, in the same manner as is adopted for other metals, or by direct application and heat. To enable this, the aluminium to be treated has to be covered with a special metallic film, after which the other manipulations are effected in the usual way of galvanic depositing.

Energy as a Dimensional Unit.—The researches and dissertations which from time to time are published by Ostwald always contain evidence that this scientist possesses a rare aptitude for grappling with the problems of physics: and the more obscure the problem the greater does this aptitude appear to be. In a recent communication to the Munich Academy he has shown great power of generalisation in the treatment of energy as a dimensional unit. He suggests the substitution of the unit of energy for the unit of mass as one of the three fundamental units of an absolute system; so that in this case all physical magnitudes would be expressed in units of energy, length, and time. He considers that it is false to assume that all such magnitudes may be expressed in units of mass, length, and time. For example, he would not consider it possible to express in centimetres, grammes, and seconds, the electric pressure of a voltaic element. He argues that whilst mass may be the fundamental quantity in dynamics, energy is the only magnitude which is common to all branches of physics. The mutual convertibility of the various forms of energy is the single bond which unites the theories of heat and of electricity, of chemistry and of dynamics. The extension of the energy idea over the entire province of physics and chemistry is formulated as follows: "In order that any system whatever, containing forms of energy, shall be in equilibrium, the necessary and sufficient condition is that for every displacement of the system, consistent with the conditions of its existence, the sum of the quantities of energy which appear and disappear shall be equal to zero."

A New Departure in Electric and Magnetic Instruments.—It is interesting to notice that entirely new departures from the general lines on which magnetic and electric instruments are constructed are possible. G. Quincke illustrates this in an article which may be consulted in the *Annalen der Physik und Chemie*, No. 1, 1893, pp. 25—34. He describes, by the aid of diagrams, some galvanometers and magnetometers, which certainly possess many novel features, constituting distinct departures from those types which are most generally known to the scientific world. A glass disc appears to be the most striking or essential portion of the apparatus. It is supported in a vertical position, and around the rim wires are clamped, whilst a mirror, fitted with a small magnet, is suspended in a hole at the centre of the disc. As thus arranged, the apparatus is capable of being used either as a tangent galvanometer or as a magnetometer. Movable coils may be placed on each side of the glass disc. The apparatus appears to be of a remarkable simple character, and this quality will commend them to instructors or demonstrators in physical laboratories who desire accuracy combined with economy in their instruments. Extreme accuracy is one of the qualities upon which Quincke lays special stress. He maintains that better readings can be obtained with his instruments than with those of the conventional type.

Note for the Dissociationists.—Students of Arrhenius's theory of electrolytic dissociation should not miss a paper by Dr. John Shields, which appears in the current issue of the *Philosophical Magazine* [Vol. xxxv., No. 215, pp. 365—388], under the title, "On Hydrolysis in Aqueous Salt Solutions." The paper was originally read before the Swedish Academy of Sciences, Stockholm, on January 11th, 1893, and has since been communicated to the *Philosophical Magazine* by the author. The investigation was undertaken at the suggestion of Dr. Svante Arrhenius, in Stockholm, and the main object in view was the determination of the amount of free alkali in aqueous solutions of such salts as potassium cyanide, sodium carbonate, &c.; that is, of all salts whose solutions exhibit an alkaline reaction, or act as mild alkalies. Readers of the Electrical Review will already be cognisant of a research on somewhat similar lines which has been carried out by Dr. James Walker, in which the relative strengths of different organic bases was measured. Dr. Walker's experimental method was based on the presence of hydrogen ions, but Dr. Shields's experiments deal with hydroxyl ions, hence he was able to work with more dilute solutions, and thus reduce perturbing influences to a minimum. Even a brief *résumé* of this long paper would be rather wide of the objects which it is necessary for us to keep in view, but we note that Dr. Shields's results appear to have an affirmative bearing upon the dissociation theory.

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Dundee Electric Lighting Station.—With reference to our account of the Dundee electric lighting station, we have been requested by Messrs. Urquhart & Small, the engineers, to add that the feeders were laid by the Callender's Bitumen, Telegraph and Waterproof Company, Limited; the distribution mains by the India-Rubber, Gutta-Percha and Telegraph Works Company, Limited; and the boilers, steam piping and condensing plant are by Messrs. Whyte & Cooper, of Dundee, the air condenser being a speciality of theirs.

Hampstead and Charing Cross Railway.—The Bill for the construction of an underground electric railway from Hampstead to Charing Cross, came last Monday before the examiner of the House of Lords, after having passed through all its stages in the Commons. The Standing Orders having been complied with, the Bill was allowed to proceed.

Burnley Electric Lighting.—The Burnley branch of the Grand United Order of Oddfellows have decided to light their club in Keighley Green by electricity.

The Electric Light in Edinburgh.—Some time ago the Corporation decided to do the electric lighting themselves; some prominent citizens objected to this, arguing that a local company would be better fitted to carry out electric light work. In consequence of the agitation, a deputation waited upon the Town Council last week to ask them to re-consider their decision. In spite of the views of the deputation and of many councillors, the Town Council, by a large majority, decided to do the lighting themselves.

Some Recent Papers on Electrolytic Separations.—Several papers of interest on this subject have recently been published. Whilst it would scarcely serve our purpose to give full abstracts, we indicate below the nature of their contents, and give the references, so that our readers may know where to seek for them if they wish to consult them in detail. "Electrolytic Separation of Copper."—Drossbach finds that on electrolysing an ammoniacal solution of copper, the metal is deposited without contamination, even though traces of silver, bismuth, antimony, arsenic, or tin may be present; mercury and cadmium, however, may interfere with the disposition under these circumstances. If the action of the current is much prolonged after the copper has been thrown down, then nickel, cobalt, or tin, if present, will also be partially deposited.—[*Chemiker Zeitung*, Vol. xvi., p. 818.] "Electrolytic Separation of Palladium and Platinum from Iridium."—Smith states that iridium is not precipitated by the electric current from solutions containing an excess of an alkaline phosphate and free phosphoric acid, whereas palladium and platinum separate readily.—[*American Chemical Journal*, Vol. xiv., p. 435.] "Electrolytic Separation of Gold, &c."—In potassium cyanide solutions gold is readily separated from arsenic, molybdenum, or osmium; also from wolfram, if WO_3 is dissolved up in potassium cyanide. If, however, this oxide is dissolved in potash, and potassium cyanide is added, the separation is unsatisfactory. Cadmium, silver and mercury are readily separated from osmium in a potassium cyanide solution, and cadmium can be separated from nickel in this solution if potash is present.—[Smith and Wallace, *Journ. An. and App. Chem.*, Vol. vi., p. 87.] "Electrolytic Separation of Various Metals."—Rudorff has been revising some of Classeus's well known reactions, and finds that those with oxalates are not so convenient as is claimed in some cases. Methods are given for the separation of gold in potassium cyanide, platinum in sulphuric acid solution, silver from copper, mercury from copper, cadmium from copper, and copper from nickel.—[*Zeits. Angewandte Chem.*, 1892, p. 695.] "Separation of Lead from Galena."—L. Medicus has recently proposed a method of separating lead from galena, which seems likely to develop considerable technical utility, on account of its being both accurate and rapid. The lead is obtained from galena as chloride, by means of hydrochloric acid. This is then dissolved in potash, and precipitated as carbonate by means of carbon dioxide. The carbonate is next dissolved in nitric acid and electrolysed, whereby the metal is obtained in the state of peroxide.—[*Vide Berichte der deutsche Chemische Gesellschaft.*]

Glasgow and Belfast Telephone Line.—This was opened to the public on Monday last, 24th inst. The charge for each conversation, not exceeding 3 minutes, is 5s.

The Liverpool Overhead Railway.—The train service on the Overhead Railway has now been accelerated, the time between the Pierhead and the Alexandra Dock Station being 14 minutes, and between the Pierhead and Herculaneum 11 minutes. It is hoped to run a 5 minutes' service soon. The restriction as to the use of workmen's return tickets has been modified, and they are now available to return by all trains.

The Blackening of Incandescent Lamp Bulbs.—Amongst the various theories which have been put forward to explain why the inner surface of an incandescent lamp blackens after protracted use, three appear to be based upon experimental grounds. The first attributes the blackening to the deposition of minute particles of carbonaceous matter, the source of which is the filament; the second, based on more slender evidence, attributes a portion of the trouble to residual mercury vapour, whilst the third traces a proportion of the blackening to the volatilisation of the platinum wires. In a recent paper by E. Cramer, he incidentally mentions that platinum has been found by him to "evaporate" in the vacuum of the incandescent lamp where the pressure of the electric current is increased to an unusual and improper extent. The vapourised platinum then condenses over the inner surface of the lamp, forming a thin, grey film, which considerably alters the transparency of the glass.

Possibilities and Impossibilities of Science.—Prof. A. B. W. Kennedy, F.R.S., delivered a lecture in the Royal Institution on Friday night on "Possible and Impossible Economies in Energy Utilisation," a subject which he described as of national interest, as economy in energy might mean wealth and prosperity to a nation, while waste in energy might mean diminished commerce and general depression. As an engineer he stood on the firm basis of the fact that nothing was impossible except perpetual motion and the transmutation of metals; and about the latter it was hardly safe to be sure, for Prof. Dewar might shortly tell them that at a temperature of about 273° everything was the same, the difference between gold and lead being only a matter of thermo-dynamic function. In essence, all the impossibilities he would have to mention were perpetual motions—attempts to get more out of something than was in it. He gave as instances the attempts to utilise the steam in an engine over and over again, and to make out of coal a fuel which had twice the value of the coal itself. A man who said he was going to produce 25s. out of £1 would be laughed at. To the good folk who dabbled in physics and chemistry and patents it was always possible to conceive that some new law, or force, or source of energy or what not, would rise Minerva like, fully equipped for the use of the universe, and particularly for making their individual fortunes out of a casual suggestion or a random experiment. He thought it was not impossible to arrive at some understanding as to how far existing knowledge could be held to be final and how far provisional. More than half the possibilities of economy were possibilities of improving up to the best work already done. If, for instance, the average working of steam boilers all over this country were brought up to the standard of the best working, about 30 per cent. of our coal would be saved. He analysed the working of electric light plant, compressed-air plant, and electric tramway plant, as well as steam and gas engines, and said there was no very large possibility of saving in the generation of electricity, but there was an enormous possibility of economy in utilising the current for light in the lamp itself. He also, says the *Times*, emphasised the importance of superheating steam. To sum up, there seemed to be no very startling possibilities before us except in increasing the efficiency of electric lamps and bringing up gas engines to their theoretical *maximum*. In other respects matters would develop more or less rapidly, but always less and less rapidly as they approached the limit of efficiency. There was no one point in which we had not some measurements enabling us to set bounds to the possibility of improvement, and thus to gauge the value of the pretensions made by each new method or invention as it appeared.

The Law of Copyright.—Some time ago, says the *Aberdeen Evening Press*, an action against Messrs. Barry, Henry & Co., was raised in the Aberdeen Court of Session by Messrs. Harper, Limited, craving for interdict, it being alleged that the defenders had infringed the pursuers' copyright catalogue and circulars. Messrs. Harper subsequently threatened to raise an action of damages in respect of the infringement, and the defenders have now settled the case by agreeing to pay £1,000 to the pursuers. This, it may be added, practically settles for the first time in Scotland the law regarding the copyright of trade circulars.

Bournemouth Electric Lighting.—The report of the Lighting Committee, which has been adopted by the Town Council, recommends that the town clerk be instructed to take the necessary steps to obtain the grant of a license, and that application be made to the Local Government Board for sanction to borrow the cost of the works necessary for distributing electricity pending the grant of the license. The committee also reported that they had instructed the town clerk to inquire whether, and upon what terms, the Bournemouth and District Electric Light Company would supply electricity for lighting the pier and pleasure grounds, the corporation providing the lamps and means of distribution. The estimated cost of the works for distributing the electricity for pier and gardens was said to be £3,200.

Huddersfield Electric Lighting.—The tenders of the Electrical Construction Corporation, of Wolverhampton, for the supply of main switches and fuses, and of Messrs. W. T. Henley & Co., of London, for the supply of cables, has been accepted by the Town Council. The electrical engineer has been instructed to proceed with the procuring of another 200-unit plant. Councillor Mellor, at a recent meeting of the Town Council, asked how many applications the committee had received for installations of the electric light up to the present time? Councillor Garton replied to the effect that the applications already received exceeded in number what their present machinery could perform during the coming winter. They were therefore obliged, only a few days ago, to increase their machinery by one-third. They believed now that the machinery would be ample for the coming winter.

Something New in Pulleys.—The Triple Grip Pulley and Power Saving Appliances Company are introducing a pulley made of fibrous material, which is perfectly waterproof, and upon which variations of climate or temperature have no effect. They are very light, less costly than other pulleys, and, according to published tests, have a transmitting power three times that of iron pulleys. Messrs. John C. Fell and R. W. James, who conducted the tests referred to, conclude their report as follows:—"These results show, in our opinion, a very decided advantage to be claimed for the fibre pulley, inasmuch as the reduction in tail pull for the transmission of a given amount of power will greatly reduce the dead load which exists in the mere overcoming of friction of the shafting and belting of any installation, irrespective of that due to the transmission of useful and available energy; for example, with fibre pulleys the amount of energy absorbed in friction due to the tension of the belts would only be 29 per cent. of that absorbed when iron pulleys are used."

Telephonic Communication in the United Kingdom.—Balloons are known to be largely dependent on gas, but what balloon societies have to do with telephones, which are only used for talking, it is difficult to see. However distant the connection, the Balloon Society of Great Britain has discussed the subject of "Telephonic Communication in the United Kingdom," and has passed a resolution declaring it to be the duty of the Postmaster-General to facilitate the extension of that communication, an amendment in favour of giving "freedom of action" to the companies being lost. Now that the matter has been discussed and voted upon by the Balloon Society, the Treasury will no doubt consider it only waste of time to put any proposals before Parliament, and the Postmaster-General will be able to at once do his duty in the way that the Society has pointed out to him.

St. James's and Pall Mall Electric Light.—The electric current sold for the quarter ending March 25th last amounted to £10,119, as against £10,024 for the quarter ending March 31st, 189?, a period of six days more.

Private Bills in Parliament.—The Bill of the Kensington and Knightsbridge Electric Lighting Company for the removal of gates from London streets has passed the examiners in the House of Lords.

Southampton Docks Electric Lighting.—The installation of the electric light is rapidly approaching completion. About 400 lamps have been put in the sheds at the new Empress dock, the extension, and other parts. There are already twenty lamps of 3,000 C.P. each on the quays, and nearly all the mains are laid. Two additional lamps of 3,000 C.P. each have been erected on the American Line quay. One of the combined sets of engines and dynamos have been running satisfactorily for some time, and the other two sets are expected to be in working order by the end of May. New large boilers are being fixed to replace the temporary arrangement. The work at the docks has been carried out by Messrs. Crompton & Co., under the supervision of Mr. B. Holmes Jenkinson, A.M.Inst.C.E.

Bristol Electric Lighting.—On Friday the Bristol Town Council sanctioned the borrowing of £50,000 from the Corporation of Leeds, and £16,000 from the trustees of the Bristol General Hospital, on interest at the rate of 3½ per cent. per annum, for the purposes of the electric light installation in the city. The committee in their report asked to be allowed to make the necessary arrangements for borrowing an additional £17,000, the estimate having been exceeded, but at the request of the chairman, the Council allowed this part of the report to be withdrawn, communications having passed between the committee and Mr. Preece, which led the chairman to believe that there might be an alteration in the figures. It is announced that both for public and private purposes the light will be ready early in September. Within 10 days of the issue of circulars 3,800 incandescent lamps had been applied for, and already the mains had been laid under several of the principal thoroughfares. At the central station there are 7 boilers, supplied by Messrs. Tinkers, of Hyde; 8 dynamos, but foundations have been laid for four others; two 210-kilowatt alternators, and two 88-kilowatt ones. These are all at a pressure of 2,000 volts. The arc light dynamos will each supply a current of 80 amperes at 650 volts to the arc lamps, arranged 12 in series and 8 in parallel. The whole of the condensing plant has been supplied by W. H. Allen and Co., of Lambeth, surface condensers being used. In the streets the arc lamps will be 1,500 nominal candle-power, and they will be at a distance of 50 yards on alternate sides. In one thoroughfare, which is very wide, the lamps will be in the middle of the street. The high pressure cables are concentric, and the distributing mains treble concentric, the distribution being on the three-wire system. Messrs. Siemens Bros. & Co. have supplied the whole of the electrical machinery and mains. The resident electrical engineer is Mr. H. Faraday Proctor, who is superintending the work.

Fatal Accident.—A singular electric accident is reported from Berlin. In one of the theatres there, says the *Manchester Guardian*, a piece is given in which, during the first act, there is a thunderstorm. In order to produce the lightning, two electric cables are used, the ends of which terminate in carbons, like those used for electric lamps. When a flash of lightning is to be produced, a man behind the scenes unites the poles of the two cables, which produce an electric spark, and the thing is done. For some time past a workman occupied on the stage had always watched the lightning producer with the greatest attention. The other day, during a rehearsal, he thought he would like to try his hand at it. He took hold of the cables and produced the flash; but in consequence of some awkward handling on his part, the electric spark struck him, and he fell to the ground completely paralysed. He was taken to the hospital, but all medical skill was in vain, and he died shortly after.

Watford Electric Lighting. — The Local Board have decided to apply for a provisional order.

Society of Arts.—On Wednesday, May 3rd, at 8 p.m., a lecture will be given on "Practical Electrical Problems at Chicago," by Prof. Silvanus P. Thompson, F.R.S. Mr. W. H. Preece, F.R.S., will preside.

Leicester Electric Lighting.—The Ratepayers' and Property Owners' Protection Association have presented a petition to the Mayor against the introduction of the electric light.

Blackpool Electric Lighting.—The corner-stone of the Corporation Electric Lighting Station, in course of erection, was laid by the Mayor of Blackpool last Saturday afternoon.

Electric Lighting in Islington.—The report of the Electric Lighting Committee referred to in our last issue, has been adopted by the Vestry.

Automatic Electric Signals.—The Automatic Electric Railway Signals Company have been showing at 39, Victoria Street, during the past few days, a model of their automatic signals. A complete description of the apparatus appeared in our issue of December 30th, 1892.

Scarborough Electric Lighting.—The Scarborough Electric Lighting Company are now getting energetically to work. The laying of the pipes for the company's mains was commenced on Friday week.

Torquay Electric Lighting.—Mr. W. H. Trentham, consulting electrical engineer, of Bristol, has visited Torquay at the invitation of the Corporation, and inspected certain districts with a view to the immediate installation of the electric light.

The Royal Society.—The following paper was down for reading before this Society last evening:—"The Electric Organ of the Skate: Note on an Electric Centre in the Spinal Cord," by Prof. J. C. Ewart.

Worcester Electric Lighting.—The City Council have adopted the recommendation of the Watch Committee to apply for a further £9,000 to build a generating station for electric lighting purposes. The building was originally estimated to cost £2,000, but a more substantial structure was rendered necessary owing to a change of site, and the decision to use water as well as steam-power.

Falmouth Electric Lighting.—The Urban Sanitary Authority has decided to defer engaging an expert to report on the electric lighting scheme until tenders have been invited from public companies to light the town.

Willans Memorial Fund.—It has been thought very desirable by some who knew the late Mr. Willans personally, and knew the value of his work, that steps should be taken to aid in perpetuating his name in connection with the branch of engineering in which he so greatly distinguished himself, and in which his knowledge and experiments, always freely placed at the service of everyone, were and still are so useful. It has been considered, after discussion, that the most desirable way of doing this would be to establish a fund from which a premium might be awarded annually or biennially, or at such periods as might be thought fit, for a paper on such a general subject as the utilisation or transformation of energy, treated especially from the point of view of efficiency or economy. It has been further thought that it would be advisable to ask the Councils of the Institutions of Mechanical and Electrical Engineers to become joint trustees for this fund, and to award the premium in alternate years to the best paper bearing upon the subject mentioned which had been presented to them in the interval, the premium not to be awarded in case of no paper of sufficient merit being presented. It is proposed that the fund necessary for this purpose, to be called the Willans Memorial Fund, should be collected by subscription, the subscriptions (unless anonymous), being limited to sums not exceeding two guineas, and Mr. Alexander Siemens has consented to become treasurer.

Folkestone Electric Lighting.—The proposal to introduce electric lighting into Folkestone has been renewed, and the Corporation have appointed a committee to go into the subject, with power to consult a practical electrical engineer at a fee not exceeding £50.

Lectures.—Under the auspices of the Croydon Chamber of Commerce, Mr. Robert Hammond delivered, on Tuesday last week, at the Public Hall, Croydon, a lecture on "The Electric Light."

On Thursday evening, last week, Mr. W. H. Preece, F.R.S., gave a lecture on "Electricity," at the Emmanuel Schools, Mill Lane, West Hampstead, in aid of the school building fund.

NEW COMPANIES REGISTERED.

Baily and Grundy, Limited (38,694).—This company was registered on the 24th inst. with a capital of £10,000, in £10 shares, to acquire and take over as a going concern the business now carried on by Robert Major Baily, at Amberley Works, Amberley Road, Paddington, W., under the style of Bailey and Grundy; and to carry on the business of electricians, mechanical engineers, and manufacturers, workers, and dealers in electricity, motive power, and light, and any other business in the application in which electricity may be useful. The subscribers (with 1 share each) are: R. M. Baily, Amberley Works, Paddington, engineer; A. Grundy, 32, Brassey Square, S.W., electrician; E. Nathan, 168, Alexandre Road, accountant; G. A. Knight, Brondesbury Road, N., engineer; C. S. Winbush, East Dulwich, draughtsman; F. A. A. Simons, Camberwell, engineer; S. B. Tatham, Berkeley Square, electrical engineer. The above gentlemen are to be the first directors of the company, until it is determined to the contrary; qualification, £50; remuneration, £100 per annum and one-third of the profits after a 6 per cent. dividend has been paid. Registered by Hubert Otley, 16, Shaftesbury Avenue.

Merveilleuse Electric Arc Lamp Syndicate, Limited (38,699).—This company was registered on the 24th inst. with a capital of £15,000, in £1 shares, to adopt and carry into effect, with or without modification, an agreement dated the 20th inst., and made between Emilio Zuccani and A. Conder, for the purchase of the patent rights of the "Merveilleuse" electric arc lamp for the United Kingdom of Great Britain and Ireland, and to carry on the general business of electricians. The subscribers (with 1 share each) are:—A. R. Smith, Grove Road, Bow, E., clerk; R. E. Ferry, Crown Court, E.C., stationer; W. Knight, 38, Essex Street, E., clerk; J. Amiers, Kentish Town, clerk; J. D. Bonghey, Clapham Junction, clerk; H. Powell, 8, Brownswood Park, N., clerk; W. R. J. Mass, West Hampstead, clerk. The rules of table "A" usually apply. Registered office, Crown Court, Old Broad Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Foreign Electric Date and Time Stamp Company, Limited.—It has been thought desirable to wind this company up, and Mr. R. Warner, of 32, Walbrook, has accordingly been appointed liquidator. A new company will probably be formed.

Nottingham Electric Light and Power Company, Limited.—The shareholders of this company have decided to wind up their concern, and have appointed Mr. W. Griffith, Low Pavement, Nottingham, as liquidator.

Planet Electrical Engineering Company, Limited.—The annual return of this company has been filed at Somerset House, and it appears that out of a nominal capital of £20,000 in £5 shares (subsequently increased to £30,000 in shares of the same proportion), 3,382 shares have been taken. 800 of these have been issued as fully paid, and £12,910 has been remitted upon the remaining 2,582 shares.

Scarborough Electric Supply Company, Limited.—The statutory return of this company was made on March 24th, and shows that out of a nominal capital of £50,000 in £10 shares, 1,980 have been taken up. A call of £4 per share has been made upon these, and the payments resulting from this reach £7,912. There is still £8 in arrears.

W. T. Henley's Telegraph Works Company, Limited.—The annual return of this company, up to the 31st ult., has been filed at Somerset House, and shows that out of a nominal capital of £100,000 in 7,000 ordinary and 3,000 preference shares of £10 each, 6,837 ordinary, and all the preference shares, have been taken up. The full amount has been called, and £98,370 (the sum constituting the calls) paid.

Railway Automatic Electric Light Syndicate, Limited.—The capital of this company has been increased from £10,000 to £25,000, by the creation of 600 shares of £25 each.

Sunbeam Lamp Company, Limited.—The annual return of this company has been made at Somerset House, and shows that out of a nominal capital of £25,000 in £10 shares, 1,595 shares have been taken up. There has been £10 called up on each of 213, and £1 on each of 525 shares. The total amount of calls received is £2,625, and that agreed to be considered as paid £8,570. There is £30 unpaid, and £11,430 is the amount considered as paid on 1,143 surrendered shares.

United Electric Tramways, Limited.—The statutory return of this company was made up to the 6th ult., and shows that out of a capital of £30,000, in £5 shares, 157 shares have been taken up, on which the full amount has been paid; a sum of £35 has been paid, and £750 is in arrears.

Arcas Plating Company, Limited.—The statutory return of this company has been made up to the 3rd inst., and shows that out of a nominal capital of £80,000 in £1 shares, 17,908 have been taken up, 2,407 of which have been issued as fully paid. There has been a sum of 10s. per share called on the remaining 15,501, and the payment resulting therefrom is £2,593 10s. An amount of £5,157 is in arrears.

Akester Electric Syndicate, Limited.—The statutory return of this company has lately been filed, and discloses the fact that out of a registered capital of £15,000 in £50 shares, only the original seven subscribers' shares have been taken up. No calls, however, have been made upon these.

Phosphor Bronze Company, Limited.—The annual return of this company has been filed at Somerset House, and shows that out of a nominal capital of £150,000 in 15,000 preference and 15,000 ordinary shares, all of £5 each, 8,375 preference and 7,335 ordinary shares have been taken up. The full amounts have been called on these, and £78,550 has been paid, together with £11,560 on the forfeited shares.

House-to-House Electric Light Supply Company, Limited.—The annual return of this company has been made up to the 16th ult., and shows that out of a nominal capital of £350,000, in 57,900 ordinary, 100 founders', and 12,000 preference shares of £5 each, 8,322 ordinary, 100 founders', and 4,291 preference shares have been taken up. The founders' and 1,000 of the ordinary shares have been agreed to be considered as paid. The full amounts have been called on the remaining 7,322 ordinary, and 4,241 preference shares. £2 has been called on the other 50 preference shares, resulting in a total payment of £57,915. There is £50 in arrear.

Liverpool Electric Supply Company, Limited.—The annual return of this company was made a few days ago, and shows that out of a capital of £300,000, in £5 shares, of which 40,000 have been taken up, the full amounts have been called on 10,000 of these, and £3 10s. upon the remainder. The total sum of calls paid reaches £175,130.

Woking Electric Supply Company, Limited.—The annual return of this company has been made up to the 19th inst., and shows that out of a capital of £20,000, in 4,000 shares of £5 each, 2,965 shares have been taken up. There have been 2,873 shares issued as fully-paid; 5s. has been paid on 20, 10s. on another 20, and 25s. on 52 shares. The total amount of calls received is £85; £35 is still unpaid.

Cambridge University and Town Electric Lighting Company, Limited.—The registered office of the above-named company is now situated at Philo Chambers, 63, Sidney Street, Cambridge.

Phonopore Company, Limited.—The registered office of this company has been changed from 27, Clement's Lane, E.C., to Faraday House, Charing Cross Road, W.C.

Queen Anne's Mansions Lighting and Heating Company, Limited.—The registered office of this company is at 251, Winchester House, E.C.

Provincial Electric Light and Power Company, Limited.—According to a notice filed at Somerset House, the registered office of this company is still situated at Westminster Chambers, 5, Victoria Street, S.W.

South of England House-to-House Electricity Company, Limited.—The registered office of this company is now at 15, St. Helen's Place, E.C.

Scottish House-to-House Electricity Co., Limited.—The registered office of this company is at 15, St. Helen's Place, E.C.

Paddington and Bayswater Electric Light and Power Supply, Limited.—The registered office of this company is at 13, Victoria Street, Westminster, S.W.

Tayler-Smith Electric Company, Limited.—The registered office of this company still remains at 53, South Molton Street, W.

Akester Electro-Motor and Accumulator Company, Limited.—The registered office of this company is now at 6, Ropemaker Street, E.C.

Windsor and Eton Electric Light Company, Limited.—The registered office of this company is now at Acre House, Bachelors' Acre, Windsor, Berks.

CONTRACTS OPEN.

Clonmel—May 25th. Tenders for electric lighting the streets of the town, and the Town Hall. For full particulars see our advertisement pages.

Liège—June 15th.—On June 15th the Mayor and Council of Liège will attend at the Town Hall to open tenders for the establishment of a central station. Full particulars as to terms of contract and plans can be obtained from the Public Works Bureau, Town Hall, Liège.

Powderhall (Edinburgh)—April 28th. For an installation of electric light at the Refuse Disposal Works, Powderhall. Particulars, copies of specification, and forms of tender may be obtained from the Burgh Engineer, Police Chambers, where plans may also be seen. Tenders must be lodged with Mr. Wm. Skinner, W.S., town clerk, City Chambers, Edinburgh, on or before 28th inst.

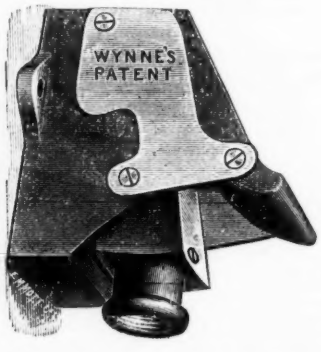
BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), is now ready, 784 pp. This standard work contains a larger amount of trade information than any other similiar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

The City Electric Lighting—The City of London Electric Lighting Company give notice that, unless unforseen circumstances arise, electric energy will be laid on within the next few months in the following areas: (1) Fetter Lane sub-area, bounded by High Holborn, St. Andrews Street, Shoe Lane, Fleet Street, and western city boundary; (2) St. Andrews Hill sub-area, bounded by Ludgate Hill, St. Paul's Churchyard, Godliman Street, St. Paul's Wharf, River Thames, and New Bridge Street; (3) Warwick Square sub-area, bounded by Newgate Street, St. Paul's Churchyard, Ludgate Hill, and Old Bailey; (4) Crosby Square sub-area, bounded by old Broad Street, Wormwood Street, Houndsditch, St. Mary Axe, and Leadenhall Street; (5) Bartholomew Close sub-area, bounded by northern city boundary, Aldersgate Street, St. Martin's-le-Grand, Newgate Street, and Holborn Viaduct; and (6) Falcon Square sub-area, bounded by Jewin Street, Fore Street, Aldermanbury, Gresham Street, and Aldersgate Street. Consumers will be connected up in the order of application, provided they are ready to receive current when the company is ready to supply. To enable the company to make timely provision, all applications should be sent in as early as possible. Forms of application and all particulars can be obtained at the office, 1 and 2, Great Winchester Street.

Shop Window Electric Lighting. — One of the branches of the electric lighting industry which has been receiving a good deal of attention lately, is that which embraces the lighting, both external and internal, of shop windows. The efficient display of all kinds of goods can only be obtained by careful and judicious lighting arrangements. Messrs. Wynne & Barnard, of 72, Grey Street, Newcastle-on-Tyne, have given this subject special attention, and one of their improved arrangements for facilitating the external lighting of shop windows is shown in the cuts appended. It consists of an

appliance, by means of which a reflecting lantern may be attached to a shop front, or taken down in a moment by the most inexperienced shop assistant. A waterproof hood with a large open mouth is permanently fixed to the shop front, and into this is placed a movable contact piece attached to the lantern. The contact piece is inclined at a slight angle when passing into the hood, and when allowed to



fall into its vertical position, the two parts lock into one another and prevent any swaying motion of the lamp. The rubbing contacts are made by two strong flat springs which are highly insulated by being attached at only one place near the top of the hood to an ebonite plate. Its main advantages claimed for it are:—The hood is perfectly watertight, and the electrical contacts highly insulated. The electrical contacts are perfect and of ample size to carry the current. Absolute simplicity in use, enabling the lamp to be put up or taken down with the greatest ease by the most inexperienced person. It is self-locking and perfectly rigid. The lantern cannot be accidently knocked out of place. It is cheaply manufactured and can be made as strong as may be desired. The makers are adapting this junction for various purposes, including lighting, heating, signalling, &c., on railway trains, lighting and heating private houses, and in other places where light or heat is only occasionally required and it is inconvenient to have the apparatus always in position.

Bankruptcy.—An examination was held a few days ago in *re* Arthur H. W. Redcliffe, of Claremont House, Claremont Road, Handsworth, electrical and telegraph engineer. Debts amounted to £919, and assets £157. Mr. J. O. Dale appeared for the bankrupt. The bankrupt commenced business in 1877, and was for a long time successful, but owing to the loss of contracts and illness his business declined.

The Electric Light in Leicester.—Professor Kennedy has given his report to the Corporation Gas Department on the two selected schemes and tenders for the electric lighting of the "limited area" of Leicester. Having dealt with certain preliminary details and modification of prices, Professor Kennedy says the total prices of the Brush Company and Messrs. Ferranti come out as £26,517 and £23,225 respectively. He continues:—The former firm, however, tender for considerably larger plant than the latter, so that the price per net effective kilo-watt—which is, perhaps, the best standard of comparison—is £55·8 only, as against £53·4. As, however, the Brush Company are somewhat more liberal of engine power than Messrs. Ferranti, the price per total indicated horse-power is practically the same, being £23·1 for the Brush, and £23·2 for Me-srs. Ferranti. In the matter of price it appears to me therefore, that the costs compared with value are practically the same in the two cases. The two firms practically tender also for the same system, although there are differences in the primary voltage, and also in the number of alternations per second. I have grave doubts whether, in either case, the boiler power specified is sufficient—always leaving one boiler in reserve to supply the required amount of steam for the full power. In this matter, however, there is very little difference between the two firms. Neither firm has provided, so far as I see, for any means of taking transformers out of circuit during the night hours or during light loads at day time. At this I am somewhat surprised, but it does not constitute a point of difference between the two tenders, or lead me to give preference to one or the other. In both cases transformers can be cut out by hand during the summer, or for other lengthened periods, but not to meet the ordinary hourly alternations of load. Each of the contractors claims, I believe, that he above all others has successfully solved the vexed question of supplying satisfactory alternating current motors. I am sorry that experience in this matter is, as yet, so small that I am unable to say whether either or both firms concerned have really succeeded. I presume from the prominence which is given to this matter that you have had reason to believe that the motor question in Leicester will be an important one. At present, unfortunately, it has proved very unimportant in almost every place where electric lighting has been carried out. The two tenders being thus so exceedingly alike in their general scope, both in what they propose to do, and what they do not propose to do, I have had to base my decision on general grounds rather than on details, and I have to advise you that, in my opinion, of the two tenders submitted to you, the tender of the Brush Company is, on the whole, the more advantageous, and I recommend you to accept it in preference to the tender of Messrs. Ferranti. I notice that in Mr. Colson's analysis of the tenders there is mentioned only the horizontal engines tendered for by the Brush Company. Their second tender was for either horizontal compound, or vertical inverted triple-expansion engines. I do not know whether there are any special reasons which may have induced you to pass over the last-named alternative, but I have no hesitation in saying that from the engineering point of view the marine triple-expansion engines are preferable to the horizontal compound. The contractors also appear to consider, I believe rightly, that they would be considerably more economical in steam. If they were used, there is no reason why they should not be worked at 150 lbs. pressure, which the Babcock boilers can carry as easily and as safely as the lower pressure proposed.

Affairs of Fowler, Lancaster & Co., Limited.—In the Chancery Division, London, on Wednesday last, the case of Fowler, Lancaster & Co. came before Mr. Justice Williams, the judge under the Companies Winding-up Act, on the petition of the Electrical Company of London. The petitioners were creditors for a debt of £159 due on a dishonoured bill, and they petitioned for an order for compulsorily winding up, notwithstanding that voluntary liquidation had been resolved upon. Mr. Hart appeared in support of the petition. Mr. Farwell, Q.C., appeared for the company and opposed the petition. Mr. Hart said the company had carried on business at the Albert Works, Graham Street, Birmingham. The ground of the petition was insolvency and failure of the company. The failure was attributed to lack of sufficient capital to work the business economically, general depression in trade, and the crisis through which the electrical trades had lately passed. Fowler, Lancaster & Co. was incorporated in 1890 with a nominal capital of £22,000, of which £17,820 was subscribed. The company was now in a state of hopeless insolvency with unsecured debts amounting to £6,500, and debentures £7,000. Under these circumstances the unsecured creditors thought their interests would not be sufficiently protected by voluntary liquidation conducted by the nominee of the debenture and shareholders, and asked the Court for a compulsory order. Mr. Farwell submitted that there was no ground for supposing that the ordinary creditors would be prejudiced by the ordinary voluntary liquidation. There was no suggestion that anything fraudulent had been done which necessitated an enquiry. The creditor had not shown a case for compulsory winding up. Mr. Hart said he had shown sufficient grounds on the affidavit that the liquidation should be conducted by the Official Receiver, or some independent person in whom the creditors had confidence. The present voluntary liquidator had told the creditors that in his opinion there was nothing whatever to come to them. Mr. Justice Williams remarked that private liquidators generally showed a want of energy in making enquiries. The petition was ultimately adjourned for evidence as to the formation and working of the company.

Woodhouse & Rawson United, Limited.—A petition was presented to the High Court of Justice on 25th inst. by Charles E. Challis, machinist, a creditor of the company, for winding up. The petition was directed to be heard on May 17th, before Mr. Justice Vaughan Williams at the said court. Creditors, or others, desirous to support or oppose the making of an order for the winding up of the company, should appear at the time of hearing for that purpose.

Hartmann and Braun's Electrical Governor.—Every engineer in charge of a central station has felt the need of a sensitive and trustworthy electrical governor, which does not depend for its action on the care of attendants. Such an instrument should control the station by acting on the exciting current of the dynamo, or, if batteries are used, on the switch which controls the number of cells in use. The essential part of such a piece of apparatus is an accurate standard voltmeter, which is specially sensitive between the limits of variation of pressure allowed. This instrument must be as free from errors of all kinds as the best high-class voltmeter, and must also be able to control powerful machinery without being hampered by gear for making contacts for large currents, or working any heavy mechanism directly. It should therefore work a sensitive relay, and this relay must itself work a more powerful relay. Such an arrangement is adopted by Messrs. Hartmann and Braun for their new electrical governor. It consists of a sensitive standard voltmeter. This controls two relays, which in their turn control the current of a small motor. The motor works a screw switch which alters the number of cells in use, or in a large station controls the dynamos by varying the existing current. The voltmeter has thus to deal with a very small current itself. At the ends of the switching screw there are contacts which act on the motor circuits so as to prevent over running. This apparatus is complete in itself, and should come into extensive use in this country.

J. D. F. Andrews & Co.—This firm have removed their offices from 41, Parliament Street, S.W., to works at 15, Marsham Street, Westminster, where the business will be carried on as before under the personal direction of Mr. J. D. F. Andrews. Extensions and arrangements have been made to greatly facilitate the manufacture of the appliances, materials, plain and artistic fittings of Andrews's concentric wiring, also arc lamps, transformers, &c., and the system of mechanical ventilation by induced air currents. The partnership that has hitherto existed between J. D. F. Andrews and H. H. Gray has been dissolved as from February 28th last, and in order to facilitate the adjusting of accounts and settlement of all liabilities up to the above date, they have appointed Mr. Charles Comins, of Messrs. Schultz & Comins (chartered accountants), 46, Cannon Street, E.C., to receive on their behalf all monies due to the firm, and accounts owing by the firm up to February 28th, 1893, will be settled by him on Messrs. Andrews's behalf.

Removal.—The registered offices of the St. James's and Pall-Mall Electric Light Company, Limited, will, on and after May 1st next, be transferred to their new central station at Carnaby Street, Golden Square, W.

The National Telephone Company, Limited, announce that on and after 1st prox. their offices, so far as regards metropolitan business, will be transferred from Oxford Court, Cannon Street, to 58 and 59, London Wall, E.C. The head offices for secretarial and provincial business will remain, as heretofore, at Oxford Court.

Mr. George Stegmann, electrical engineer, late of 66, St. John's Road, has removed his works, showrooms and offices to more commodious premises at 69, St. John's Hill, Clapham Junction, S.W.

Concert.—The last of a series of four very popular concerts of the City of London Electric Lighting Company was given in the International Hall at the Café Monico on Thursday night, under the presidency of Mr. D. Cook, the manager and engineer of the company, supported by Earl Russell.

Gardening and Forestry Exhibition.—Messrs. Johnson and Phillips have contracted for the supply of upwards of 200 Brockie-Pell arc lamps for the electric lighting of the building and grounds of the Gardening and Forestry Exhibition, to be opened at Earl's Court next month.

Messrs. R. & W. Winfields, Limited.—This firm have appointed Mr. Seymour Croneen, late manager to Messrs. F. W. Reynolds & Co., of Southwark, to the charge of their London business from May 1st.

Personal.—We understand that Mr. Arthur Bergtheil sailed for the United States and Chicago by the ss. *Germanic*, which left Liverpool on Wednesday.

Gilbert & Co., of Hanway Street and Kensington High Street, are executing the electric light in the residence of the Maharajah of Bhannagar.

Electrical Accessories Company.—The London offices and show rooms of this company are now at 110, Charing Cross Road.

CITY NOTES.

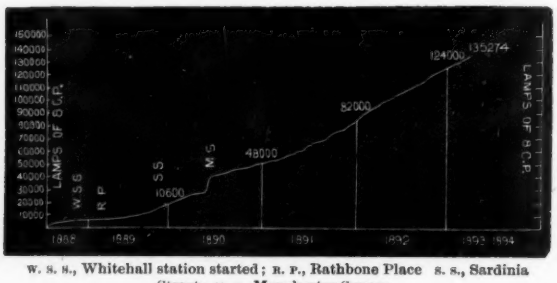
Metropolitan Electricity Supply Company, Limited.

THE sixth ordinary general meeting of this company was held at Winchester House, on Friday last, Sir John Pender, G.C.M.G., M.P., presiding.

The SECRETARY (Mr. E. Cunliffe Owen) having read the notice convening the meeting,

The CHAIRMAN said he presumed they would take the report and accounts as read. He would, in the first place, direct their attention to a misprint in the accounts as sent to the shareholders, which had been corrected in the copies placed in their hands at the meeting. Item 2 of the capital accounts showed the sums expended on buildings up to 1891 and during the past year as £127,439, but this was an error and should be £133,429; the total of the capital account, however, was not affected, and the misprint had no bearing on any of the other published accounts, but it was right for an inaccuracy of that kind to be pointed out, as no doubt many of the gentlemen present would have otherwise reminded them of it before they left the room. He would now proceed to an examination of the accounts, which he hoped were sufficiently explicit as showing the results of the year's working. There were, however, some details to which he wished to direct their attention, that they might fully realise the improvement in the position. The capital accounts Nos. 1 and 3 had little that was new; they showed that the 50,000 debentures spoken of at the last meeting were duly issued, and now form part of the company's capital, and he would state that they are almost entirely held by shareholders, which was, he thought, a very satisfactory position. They would observe that the capital expenditure of the year had been principally confined to the completion of the Amberley Road Station at Paddington with its plant and machinery, and secondly, to the extension of the underground mains, which now amounted to upwards of 200 miles, and the provision of the transformers and meters necessary for the supply of their continually-increasing customers. He would remind them, here, that the Amberley Road station was not contemplated in their original estimates; and it was, indeed, owing to the comparatively recent addition of the Paddington district to their original area that the debentures became necessary. Their original capital was £500,000, but that did not include the Paddington Station, which afterwards was brought in, and which they had now successfully established. He must not omit to refer to the item for management expenses. They had, as he had explained on a former occasion, been divided between capital and revenue on what the auditors considered to be a fair principle, having regard to the time, and attention which had been required in settling and carrying out the various details of construction, the charge to capital being a decreasing one; so that when the construction was practically completed the revenue would have to bear the whole of those charges, which he had no doubt whatever it would be perfectly able to do. There was another item which he would explain, as it appeared for the first time in the accounts, *i.e.*, expenditure relating to compensation for damage, and cost of properties acquired, £3,311 18s. That sum was in respect of one of the difficulties they had had to encounter in the carrying out of their works. It had been impossible to lay down large quantities of machinery in thickly-populated localities without provoking a certain amount of what he would call complaint. Those complaints were very often greatly exaggerated, and people in possession of land, when they found they could get a little money by finding fault, lost no opportunity in endeavouring to get it. The vibration still gives cause for complaints, which might or might not be justified; and, in some cases, rather than incur litigation, the directors had been compelled to acquire properties closely abutting on certain of their stations. He would have occasion to refer to this question later on, but would mention now that they had found no difficulty in letting such property as they had offered to tenants, and were receiving a very fair rate of interest on their purchases, so that they made no loss on that. Turning to the revenue account No. 4, the first and most gratifying point was that while the income from current had increased 35 per cent., the cost of production had only risen about 4 per cent.; the coal bill was, of course, the great item of interest, and the board were glad to find that their anticipations that the consumption of coal would not increase proportionally to the income had been fully verified; they believed that the improvement in that direction would become still greater as the business increased. They would notice in this account, also, the introduction for the first time of a depreciation fund, as he stated was their intention when he addressed them at the meeting last year; the board were fully alive to the need of providing for the wear and tear of the company's buildings and plant, more especially of such items as accumulators. It must, however, be borne in mind that their buildings were new, that the machinery was only really now settling down into full working, and every penny of expenditure incurred in keeping it in perfect order necessary for successful working had been charged directly to revenue. Their accumulators were few, and therefore would eventually cease to be an item in their system. The directors, therefore, considered that they nearly met the necessity of the case by apportioning a sum of £4,000 to that purpose, leaving the amount to be increased year by year as they might deem most desirable and practicable. It would further be seen that the board had commenced a most desirable writing off of the item of preliminary expenses, which had been reduced by a sum of £1,000, and would by future reductions be greatly diminished. After making those appropriations, there still remained a balance to credit of net profit of £11,558, and the directors recommended the distribution of the sum of £9,980 as a dividend at the rate of 4s. per share, leaving a final balance to commence the net revenue of the year 1893 of £1,578. He wished to draw their attention particularly to paragraph 6 of the report, where they referred to the fulfilment of the anticipations he had more than once expressed to the shareholders, as to the decrease of working expenses in proportion to the increase of business. They looked to this feature as a proof of the ultimate prosperity of the company; the more they could employ their machinery the more economically they could supply current. Their chief difficulty at present consisted of the character of their supply to the residential portions of their districts, and private consumers did not benefit them as a rule to the same extent as commercial consumers; the reason for that required some little explanation. It would surprise many of them to know the varying requirements of householders, for whereas some considered ten lamps would meet their requirements, others required many hundreds. It was not always the largest houses that contained the greatest number of lights; the effect of this on

their supply was not altogether satisfactory. The small consumers who used all the lamps regularly, were far better customers to the company than the large householder whose normal consumption bore an extremely small proportion to his maximum requirements. Once, twice, or three times during the year he would turn on his lamps and their machinery had to be prepared to meet this emergency, which might come at any time. It was also noticeable that this condition of affairs occurred mostly in the houses of those whose residence in London was of a limited and uncertain duration. They were, therefore, under the necessity of maintaining a certain portion of their machinery which under other conditions might be more profitably employed. The question was growing and becoming more important, so important in fact, that he thought the chances were that they would have to apply to the Board of Trade to get it rectified. To show the great difference in the yield per lamp of their various classes of customers, he thought he could not give them too much information on this subject, and it was very interesting—restaurants and other establishments, whose businesses entailed long hours, brought sometimes as much as 30s. per lamp per year, whereas many private consumers only averaged about 2s., or less. In one or two extreme cases they only got a return of 4d. per lamp installed per annum. They would see those were enormous differences which would, by-and-bye, be rectified in a way which he thought would be perfectly fair between the company and the consumers, namely, that they would have a fixed price per lamp for a certain number of lamps, so that they would always be on the safe side. If they had to provide the electricity, they would be paid for it, at all events, to a certain extent, in proportion to the number of lamps taken. To meet these fluctuations and to benefit their good customers, they had lately adopted a system of charging by sliding scale, which experience had shown to be well adapted for the purpose, but there was no doubt that the time was not far distant when an effort would be made to obtain a minimum for every lamp connected with their system. It must be understood that they did not keep plant entirely idle to cope with possible maximum demands which of course would not all arise at one and the same time. They had, therefore, the power of allowing an ample margin for taking on additional lamps without any perceptible increase of working expenses, the cost (with the exception of the small additional amount of coal) having in any case to be incurred. Experience was teaching them how far they could safely increase their lamp connection beyond the number which their machinery was calculated to supply at one and the same time, and in the light of that experience they would fill up their area better than it was anticipated would have been possible with their present plant. With regard to the number of lamps connected, the diagram which we reproduce below, shows how regular the increase has been. From the applications now in hand they had every hope that the steady demand would be maintained. They had a very large number of applications; it seemed to be steadily going, and as far as he (the



W. S. S., Whitehall station started; R. P., Rathbone Place S. S., Sardinia Street; M. S., Manchester Square.

chairman) could see, they had now covered all their expenses; they were in a position to pay a small—a very small—dividend, but a dividend that ought to improve every day that they existed. The question of street lighting, which he referred to last year, was still in abeyance, but it was possible they might be called upon at any time by the local authorities to undertake that work. They had no intention of entering into that or any contract for that purpose, except at fairly remunerative terms. He might tell them that, in regard to the City of London Company, which was now in existence, that the Metropolitan Company declined to light the City of London on the terms offered to them, and they had no reason to regret having refused to take up that work. The new street which the London County Council proposed to make from Holborn to the Strand would seriously affect their Sardinia Street station, and they had taken every precaution to protect their property and interests in Parliament. He understood, however, that the County Council did not intend to proceed with their Bill, as far as this street was concerned, during the present session. He might mention that if they had gone on, of course, when they did take the place over, they must buy it on such terms as would not make a bad bargain for the company; they would, of course, require another installation and station, and he was very much better pleased at present that they had left them alone. Judging from what he was putting before them now, every day that they existed they were a growing concern, and a flourishing concern; therefore, if they were bought up two or three years hence, they must be paid a much bigger figure than if they were bought up to-day. There was a matter which was giving them a great cause for anxiety, and that was the complaints to which he had already referred, *i.e.*, vibration at one of their stations. He was unable to say very much on this subject, as an action was pending; but he might tell them that their engineer, acting in conjunction with the best expert advice they had been able to obtain on the subject, had devised a plan for putting an end to all possible ground for complaint, and they were sanguine that the result of the works now in progress would prove successful. If he were to try to explain to them now what was being done, he would not be able to do it nearly so well as when he next had the pleasure of addressing them. They were taking such steps that, instead of their machinery resting upon an uncertain foundation, they were going to place it upon a foundation that would be difficult to move or shake in any way.

A SHAREHOLDER: Is the vibration confined to the station, sir? Is it local?

The CHAIRMAN continuing, said if they were on a bad subsoil and a bad foundation, the vibration went beyond their station, beyond the walls of the station.

SHAREHOLDER: How far does it go? Is it 50 or 100 yards.

The CHAIRMAN continuing, said that Mr. Bailey would answer that question. Their Paddington station had recently been inaugurated, and it was giving great satisfaction with regular and efficient working. He (the chairman) was present with several of the directors at the opening; they had with them the whole of the Vestry, and he could only say there was nothing but compliment paid to them for the way in which it was worked; so that they were in very friendly relations with the Vestry; their area was a very extended one, in which there was a very great scope for its being built up. In order to meet the payment due on account of that station, and to provide for the mains laid up to the end of the year, it had been necessary to incur liabilities slightly in excess of their present capital. They had also further expenditure to provide for the mains that are yet to be laid. It therefore became necessary to issue the 50,000 debentures. They were anxious the shareholders should have the first opportunity to subscribe for the new issue, and a circular would shortly be issued to them on the subject, offering them the debentures *pro rata*. He had taken in the past himself, and he would take in the future, and no doubt there was no better security in London than the debentures of the Metropolitan Electric Supply Company. The directors desired that the shareholders should have the fullest information, as they thought it created a better feeling betwixt the shareholders and the directors. He would make a few remarks, giving them a little knowledge of their experience. Electricity is comparatively in its infancy. They had experienced that in their telegraph system, but the telegraph system now covered an enormous area and had been a great success. When he and some of his friends sitting round him, a number of years ago, saw that electricity was kicked about very much in the City of London, on paper, they thought the time had come when they ought to establish a system of electric lighting that would be, at all events, honestly constructed and faithfully and carefully carried out. They took advantage of the very best information; they had no speculation at all in their system. They took up systems which had proved successful in producing the light, and also in giving a fair return upon the investment. Since then they had been learning something every day. When they first issued their prospectus they believed—he believed most confidently himself—and when Edison was over here he paid him (the chairman) a visit, and he also believed that they would get at least 25s. a lamp, and probably more. They said they would take the modest sum of £1. If they had got that sum upon every light upon their register at the moment, they would be declaring a dividend of 10 per cent. now. That was with reference to the past. He believed the average of their lights was not more than 10s. He had told them that it went from 4d. to 30s per annum, but this he would say, that there would be by-and-bye a price fixed for every light, and as they had now surmounted all their difficulties in knowing something of the cost of electric lighting, he thought he was prepared to say they could produce as cheaply, if not cheaper, than any of the existing companies. There was one feature he must speak about; they would be asking, "Why are you not paying a larger dividend?" The answer was that they had a much wider area to supply. It would take a much longer time to fill up that area, but when they had filled up that area, they would be much like the gas companies. There were economies that would be made in electric lighting which would add largely to the dividend side. When he mentioned that they had laid down 200 miles of mains, they must remember that with the pipes, the cable, and the laying of them, every mile of those mains cost them over £1,600. They had laid down a very large number, and provided for a very large increase in their light consumption, and therefore, while they were not paying so large a dividend, they were laying the ground foundation for paying larger ones in the future. When they originally contemplated that work, they felt that electricity, as a motive power, was likely to be largely used; they still believed that would take place, but they had had all their attention turned so far upon producing the light and getting their installations, that they had not turned their thoughts in the slightest degree to that. When they went to Paddington to the opening of the station the other day, he saw there Mr. Crompton with all his beautiful appliances for cooking, using the electric light—some of the prettiest things he had seen for a long time. This was one of the things which must certainly eventually take a great hold, not only in the large houses, but in the small houses throughout the country, and with their extended area he thought the company were likely to utilise electricity at a time when it was not so much used for lighting, as motive power and for cooking would be needed during the day, whereas the electric lighting only took place at night. Doubtless there would be many improvements take place in their system, and he thought that those who were in at the beginning of the system, if they had courage to hold on, would find eventually they had one of the safest and most steadily increasing investments that existed. The gentleman to whom he referred just now wrote stating that he had carefully considered, in cooking, the cost of electricity as against gas, and he said that electricity cost him only 25 per cent. more than gas. If electricity could be produced on a very large scale, only costing him 25 per cent. more than gas, he (the chairman)

believed that most people would go in for electricity. He then gave them an illustration of the economy practised by consumers. He practised it himself at his own house, by turning the light off immediately it was not wanted, and thus avoiding waste. The directors had set an example in economy by reducing their fees by 25 per cent. After some rather lengthy remarks regarding directors and their work, and regarding the addition to the board of Sir Eyre Massey Shaw, he remarked that they had had persons associated with them who had not occupied a very good position lately in the courts of law. When they first took up this concern they took up what was known as the Whitehall installation, which was owned by a combination with which Mr. Jabez Balfour, Mr. Wright, Mr. Hobbs, and others were connected. These gentlemen were associated with the building of large mansions known as Whitehall Court. When the whole of that large building is lighted it will be a very good thing for the company, but, unfortunately, the suites of rooms there had not let quite so rapidly as was expected. The Whitehall installation was taken over on a valuation by Sir Frederick Bramwell and Sir Whittaker Ellis. Two of the gentlemen connected with the Whitehall Court (Messrs. J. Balfour and Wright) attended the board for a short time, but they had very little influence. At the time Mr. Balfour was on the board he was a very popular member of Parliament, and was very much employed by the Radical section of the Liberal party in delivering speeches in all parts of the country; in fact, he was so popular that he was said to be an aspirant to Cabinet rank. He (the Chairman) certainly looked upon him as a public man who occupied an honourable position in the country. He had, however, been mistaken. It was painful for him to have to refer to these gentlemen, but he thought it right to frankly explain to them the company's position with regard to that unpleasant matter. He then formally moved: "That the report and accounts for the year ended December 31st, 1892, presented to this meeting, be, and are hereby, approved and adopted, and that a dividend of 4s. per share on the whole of the ordinary shares of the company be, and the same is hereby, declared, and such dividend of 4s. per share be payable on April 29th, 1893, to all holders on the company's register on April 15th, 1893."

Sir GEORGE ELLIOT, Bart., seconded the motion.

A SHAREHOLDER asked when it was the intention of the board to issue the debentures?

In reply, the CHAIRMAN said they were going to issue them immediately after the meeting, and shareholders would then have the opportunity of taking the *pro rata* shares at par.

Mr. BOLTON enquired how the item of £4,787 in the capital account for rent, rates and taxes, salaries, directors' fees, and other expenses was made up, and upon what basis.

Mr. GRIFFITHS (the auditor), in reply, said that the basis of the apportionment was as follows:—Whenever an expenditure had been clearly an expenditure on revenue account, it had been charged to the revenue; but whenever it had been an expenditure on capital account, it had been charged to capital. The expenditure incurred in conducting the business of the company during the year had largely consisted of construction, and it had been necessary to make an apportionment of the various expenses, which he thought was a proper course. The proportion of expenses in the capital account for directors' fees, including the managing director, was £2,270; the proportion of head office salaries was £952; printing, £246; postage and telegrams, £52; travelling expenses, £90; head office expenses, £52; office rent and taxes, £598; insurance and general expenses, including debenture stamps, &c., £521.

Mr. ADAMS suggested that the shareholders should receive a report from the board quarterly or half-yearly.

The CHAIRMAN stated, in reply, that if there were any wish on the part of the shareholders for half-yearly meetings, the board would take the matter into their consideration.

The motion was then put and carried unanimously.

Admiral-of-the-Fleet Lord JOHN HAY proposed the re-election of Sir John Pender, Sir James Anderson, and Sir George Elliot as directors of the company.

This was seconded and carried.

Messrs. Deloitte, Dever, Griffiths & Co. having been reappointed auditors,

A vote of thanks to the chairman and directors having been acknowledged by the CHAIRMAN, the meeting closed.

The West Coast of America Telegraph Company, Limited.

THE directors' report, to be submitted to the sixteenth ordinary general meeting to be held on 2nd ult., at Winchester House, reads as follows:—

"The directors beg to lay before the shareholders the balance-sheet of the company for the year ended December 31st, 1892. Pending the construction of the land line between Buenos Ayres and Valparaiso—which is being pushed forward as speedily as possible by the Pacific and European Telegraph Company, Limited—no improvement in the traffic receipts was to be expected, the business of the company being meanwhile virtually restricted to local messages. The completion of the new line will, however, re-open a direct service between the company's stations and Europe, *via* Lisbon, and thus enable the company once more to handle European traffic at all its stations. The gross income for the year 1892, as shown in the annexed accounts, was £22,218 16s. 9d., against £35,624 16s. 5d. in 1891, and in order to continue meeting the debenture coupons with regularity, it was necessary this year to take £10,287 8s. 2d. from the reserve. The receipts include the sum of £4,782 13s. 6d. from the Chilian Government, in settlement of the company's claim for damage to the cables during the revolution in 1891. The total expenses were £21,919 14s. 8d., against £24,406 19s. 7d. in 1891, showing that a real economy has been effected under this heading. A concession has been obtained from the Chilian Government for an extension of the company's cable to Talcahuano, with a land line to the city of Concepcion; the rising importance of this City, which is the centre of trade for the south of Chili, holds out a prospect of a considerable increase of traffic, both locally and by means of the new line to the East Coast and Europe. The new cable was shipped for Talcahuano in February. Mr. J. Denison Pender and Mr. Frederick Walters are the directors retiring by rotation; both are eligible and offer themselves for re-election. The auditor, Mr. John Francis Clarke, retires, and is eligible for re-election.

The Brazilian Submarine Telegraph Company, Limited.

THE directors' report for the half-year ended December 31st, 1892, to be submitted to the thirty-ninth ordinary general meeting on May 3rd, reads as follows:—

"The directors submit the accounts and balance-sheet for the half-year ended December 31st, 1892. The revenue for this period amounted to £113,891 15s. 8d., and the working expenses to £24,536 6s. 6d. After providing £12,880 for debenture interest and sinking funds, and £1,547 19s. 6d. for income tax, there remains a balance of £74,927 9s. 8d.; to this is added £3,073 8s. 5d. brought forward from June 30th last, making a total of £78,000 18s. 1d. First and second interim dividends amounting to £39,000 have been paid, and £35,000 transferred to the reserve fund, leaving the sum of £4,000 18s. 1d. to be carried to the next account. The receipts for the half-year include the sum of £1,500 dividend to June 30th, 1892, on the company's shares in the African Direct Telegraph Company, Limited. In accordance with the provisions for repayment of the first issue of debentures, dated July 31st, 1884, 177 bonds, representing £17,700, were drawn on the 17th instant, for payment at par on July 31st next. This, with the previous drawings, will make a total repayment of £131,300, leaving £18,700 of the first issue of debentures outstanding. In view of existing competition, the directors have found it advisable to make a further reduction in the rates to and from South America. During the last six months several repairs have been successfully carried out; but, in consequence of the duplication of the company's cables, the traffic was not interrupted. Arrangements have been made whereby the duplex system referred to in the report for the general meeting of May 4th, 1892, can now be applied to either of the company's cables. The land line from Buenos Ayres to Valparaiso to connect the West Coast of America cable with the East Coast cables, referred to by the chairman at the general meeting held October 19th last, is being erected with all possible speed, and the directors anticipate the line will be opened for traffic in about three months. The principle of establishing staff pension and superannuation funds has been carefully considered by your directors, who have had the details worked out by experienced actuaries, and a scheme will be submitted to the meeting for dealing with the matter, together with a formal resolution empowering the directors to carry out the necessary arrangements. The various sections of the company's line are in good working order."

The Western and Brazilian Telegraph Company, Limited.—At a meeting of the board of the Western and Brazilian Telegraph Company, Limited, held on Thursday last week, it was decided that after placing £15,000 to the reserve fund, and £6,674 to the debenture redemption fund, the directors would recommend at the forthcoming general meeting a dividend of 4s. 6d. per share, free of income tax, making, with the interim dividend paid in November last, a distribution of £2 10s. per cent. for the year 1892, carrying forward £2,829.

The London Platino-Brazilian Telegraph Company, Limited.—At a meeting of the board of the London Platino-Brazilian Telegraph Company, Limited, held on Thursday last week, it was decided that, after placing £1,182 to the reserve fund, the directors would recommend at the forthcoming general meeting a dividend of 4s. per share, free of income tax, being at the rate of £2 per cent. for the year 1892.

Barcelona Telephone Company.—Messrs. A. Ruffer and Sons announce that on and after May 1st they will pay at their counting-house, 39, Lombard Street, E.C., the coupon due on that date.

La Compagnie Française du Télégraphe de Paris à New York.—A general meeting of this company will be held at 4, Rue Charras (Salle Kriegelstein), Paris, on Thursday, May 25th, for the nomination of a council of management.

TRAFFIC RECEIPTS

The City and South London Railway Company. The receipts for the week ending April 23rd, 1893, amounted to £851; week ending April 24th, 1892, £807; increase £44; total receipts for half-year, 1893, £14,568 corresponding period, 1892, £13,302; increase £1,266.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 21st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,997.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, April 20th.	Closing Quotation April 27th.	Business done during week ended April 27th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 — 104	101 —104	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	51½ — 52¼xd	53 — 54	53	52½
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	92 — 93 xd	94 — 95	94½	92⅝
2,876,140*l*	Do. do. Deferred	Stock	12½ — 13	13 — 13½	13 1/16	12⅝
130,000	Brazilian Submarine Telegraph, Limited	10	12 — 12½	11⅞ — 12¼	12 3/16	12 1/16
36,400*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼ — 3½	3¼ — 3½	3 7/16	3¼
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼ — 2½	2¼ — 2½	2⅝	2 5/16
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	108 —110	109 —111	110	109
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
630,000*l*	City and South London Railway	Stock	37 — 39	37 — 39	3. ½	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	12¼ — 12⅝	12¼ — 12⅝	12 9/16	12⅜
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	10½ — 11	10½ — 11	11	10¾
$1,716,000	Commercial Cable, Capital Stock	$100	140 — 150	140 —150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	¼ — ⅜	3/16 — 5/16	¼	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅝	5¼ — 5⅝	5 9/16	5½
16,000	Cuba Telegraph, Limited	10	11⅛ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅞ — 12	11⅞ — 12	11⅞	11⅞
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15¼xd	15½ — 15⅝	15⅝	15 1/16
70,000	Do. 6 p. c. Preference	10	16¼ - 16⅜xd	16½ — 17	16⅞	16½
175,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	114 —117	115½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝ — 15⅞	15⅝ — 15⅞	15⅝	15⅝
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	106	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	113 —116	113 —116	...	...
178,700*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	101¾	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	2½ - 3	2½ - 3	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16 — 3/16	1/16 — 3/16	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2/8 — 3/8	2/8 — 3/8	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/8 — 3/8	1/8 — 3/8	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	..	...
180,227	Globe Telegraph and Trust, Limited	10	9¾ — 10 xd	9¾ — 10	10	9 13/16
180,042	Do. do. 6 p. c. Preference	10	15⅜ — 15⅝xd	15½ — 15⅝	15⅝	15½
150,000	Great Northern Tel. Company of Copenhagen	10	19¼ — 19⅝	19¼ —19⅝	19 9/16	19⅜
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	106	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 466*l* to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½ — 7½	6½ — 7½	..	..
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22 — 23	22 — 23	23 1/16	22½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 46	43 — 46	45½	44⅜
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	..
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4¼ — 4½	4¼ — 4½	4¼	4 1/16
10,000	Do. do. fully paid	5	6 — 6¼	6 — 6¼	6⅛	5⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7 — 7½	6½ - 7	7½	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —103	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	5¼ — 5½	5½ — 5⅝	5 7/16	5¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	15 — 15½	15 — 15½	15⅜	15 1/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½ — 15	14½ — 15	14⅝	14 11/16
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5½ — 5⅝	5½ — 5⅝	5⅝	5⅝
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —116	113 —116	...	...
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	5	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	...
11,802	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¾ — 8¼	7¾ — 8¼	8¼	7⅞
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¾ — 8¼	7¾ - 8¼	8¼	8¼
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	121	...
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	3 — 3½	3 — 3½	3¼	3 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	31 — 34	28 — 30	32	28½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	104	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ - 6½	5½ - 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	102	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	105 —109	98 —102	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7¾ - 8¼	7¾ - 8¼	8⅛	7⅞
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5¾ - 6¼	6 — 6½	6½	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1¾ - 2¼	1⅞ — 2¼	...	...
178,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1⅝ — 1⅞	1½ — 1⅝	1 11/16	1⅝
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11⅜ — 12½	11½ — 12	11⅝	...
4,669	Do. do do. do. 6 p. c. 2nd Preference ...	10	9½ — 10½	9½ — 10½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	110½	109½
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
109,000*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —104	101 —104	...	...
99,900	*Westminster Electric Supply Corp., Ltd., Nos. 101 to 42,953 ...	5	5½ — 6	5½ — 6	5 13/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5½—6.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100 - 103.—Electric and General Investment, shares of £5 (£1 paid) 1½—2½.—Founders' shares, 200—220.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5 5—5½.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited. Ordinary Shares £5 (fully paid), 6⅝—6⅞ xd, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼ xd.—Liverpool Electric Supply Shares of £5 (fully paid), 5 13/16—5 15/16 xd.—Manchester, Edison and Swan Company, £9 (£1 paid), 9—9.—Queen Anne's Mansions Lighting and Heating, 6 per cent. £100 Debentures, 101—103.

Bank rate of discount, 2½ per cent. (January 25th, 1893).

NOTE ON THE DISRUPTIVE STRENGTH OF DIELECTRICS.*

BY CHARLES PROTEUS STEINMETZ.

(*Concluded from page* 426.)

A remarkable behaviour was noticed with air. For higher E.M.Fs., the sparking distance in air agreed fairly well with this quadratic law; but even better still with a formula, where the parabola did not start at the origin, but from an E.M.F. of about 650 volts, so that these tests were expressed by

$$\delta = a\,v + b\,v^2 - c.$$

For lower values, below $v = 1{,}500 \sim 2{,}000$, the curve left this parabola and sloped towards the origin.

Consequently, to express the tests over the whole range, a further term has to be added, which disappears for values of v beyond $1{,}500 \sim 2{,}000$ volts. The simplest function of this character is the exponential $c\,e^{-d\,v}$, and, indeed, the tests made with air, over the whole range, were fairly well—that is, within the errors of observation—expressed by the equation,

$$\delta = c\,(e^{-d\,v} - 1) + a\,v + b\,v^2.$$

TABLE II.

DISRUPTIVE DISCHARGE THROUGH MICA.

$\delta = \cdot24\,v + \cdot0145\,v^2$.

Maximum difference of potential in kilo-volts. v	Sparking distance observed, in milli-centi-metres. δ obs.	Electro-static gradient in mega-volts per cm. g	Sparking distance calculated in milli-centi-metres. δ calc.	Difference δ calc. − δ obs. Δ	Difference in per cent. of δ calc. $\%$	Remarks. Average of
·80	·30	2·67	·20	−·10	(−·50)	1 reading.
4·80	1·50	3·20	1·48	−·02	−1·3	1 "
6·04	2·00	3·02	1·97	−·03	−1·5	2 "
6·55	2·22	2·95	2·18	−·04	−1·9	2 "
7·18	2·44	2·94	2·46	+·02	+·8	4 "
8·65	3·25	2·66	3·16	−·09	−2·9	2 "
9·66	3·60	2·68	3·66	+·06	+1·6	3 "
11·10	4·55	2·44	4·45	−·10	−2·2	5 "
12·90	5·55	2·33	5·52	−·03	−·5	4 "
16·50	8·00	2·06	7·91	−·09	−1·1	2 "
20·30	11·75	1·72	10·83	(−·92	+8·5)	1 "
12·50	6·20	2·02	...	...	...	1 "
13·60	7·50	1·81	...	...	...	1 "
14·00	8·50	1·65	...	...	...	1 "
16·20	10·00	1·62	...	...	...	1 "
19·20	15·40	1·25	...	...	...	2 "
Average ...	...	...	...	±·06	±1·5	... ...

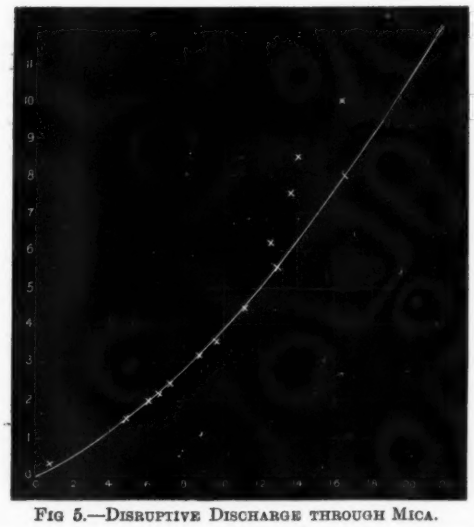


FIG 5.—DISRUPTIVE DISCHARGE THROUGH MICA.

* A paper presented at the seventy-fourth meeting of the American Institute of Electrical Engineers, New York, February 21st, 1893.

This equation is merely empirical and can consequently be expected to hold only within the range covered by the tests. Still, the terms of this equation may have some theoretical foundation.

The term $a\,v$ gives the electrostatic gradient $g = \frac{1}{a}$, at which the air while at rest under ordinary pressure breaks down.

Mechanical or other changes taking place in the air under the electrostatic stress (for instance, air currents), and being proportional to the E.M.F., may justify the introduction of the quadratic term, $b\,v^2$.

TABLE III.

DISRUPTIVE DISCHARGE THROUGH VULCANISED FIBRE.

$\delta = 7{\cdot}66\,v + 2{\cdot}3\,v^2$.

Maximum difference of potential in kilo-volts. v	Sparking distance observed in milli-centi-metres. δ obs.	Electro-static gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centi-metres. δ calc.	Difference δ calc. − δ obs. Δ	Difference in per-centage of δ calc. $\%$	Remarks. Average of
2·2	58	35	28	−30	(−107)	... ...
8·8	228	39	246	+18	+7·3	4 readings
10·1	317	32	312	− 5	−1·6	3 "
14·9	649	23	624	−16	−2·5	4 "
22·5	1,280	18	1,332	+52	+3·9	... ...
Average	...	...	...	...	±24	±3·8 ... ...

Material has perceptible electric conductivity, being apparently damp.

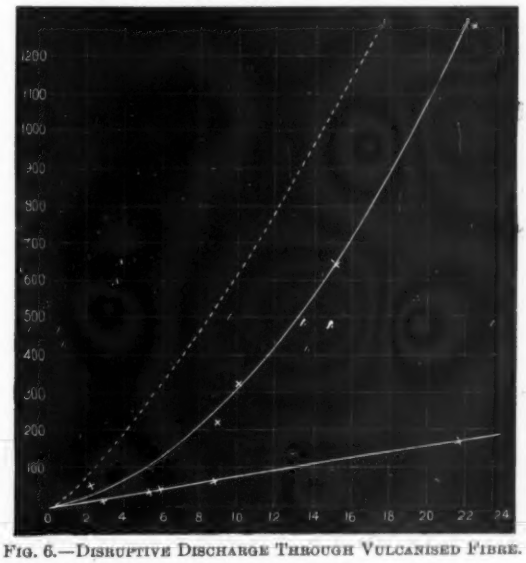


FIG. 6.—DISRUPTIVE DISCHARGE THROUGH VULCANISED FIBRE.

As known, all the solid materials are covered—by molecular attraction—with a thin film of compressed air. The disruptive strength of compressed air is greater than that of air of ordinary pressure. Consequently, these two films of compressed air must behave like an increase of the distance of the electrodes, by that length, c, which is equivalent to the greater disruptive strength of the two films of compressed air covering the electrodes. Hence, the theoretical sparking distance, $a\,v + b\,v^2$, has to be decreased by a constant, c, giving

$$\delta = a\,v + b\,v^2 - c.$$

But when approaching the electrodes so closely that the two films of compressed air unite more or less, the constant term c will be more or less decreased. Now, the density of the air near the surface of an attracting body is represented by an exponential function of the form $e^{-d\,x}$.

Hence, it is possible that this exponential term, which I noticed only in air, $c\,(e^{-d\,v} - 1)$, has a physical meaning

This is corroborated by the numerical values of a, c and d. For, calculating the electrostatic gradient of air for extremely small distances,

$$g_0 = \left(\frac{V}{L}\right)_{V\ 0} = \left(\frac{V}{c\,(e^{-dV} - 1) + a\,V}\right)_{V\ 0} = \frac{1}{a - c\,d},$$

we get 139 kilo-volts per cm. Dry fibre, a porous material, gives almost the same value, 130 kilo-volts per cm.

TABLE IV.

DISRUPTIVE DISCHARGE THROUGH DRY WOOD FIBRE.

δ = 7·66 v.

Maximum difference of potential in kilo-volts. V	Sparking distance observed in milli-centi-metres. δ obs.	Electro static gradient in kilo-volts per cm. g	S arking distance calculated in milli-centi-metres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per-centage of δ calc. %	Remarks. Average of
2·8	22	127	21·5	− ·5	−2 3	3 readings.
5·8	44	132	44·4	+ ·4	+ ·9	3 „
8·8	66	133	67·6	+1·6	+ 2·4	2 „
21·6	169	128	165·5	−3·5	−2·1	3 „
Average		130	Average	±1·5	±1·8	... ...

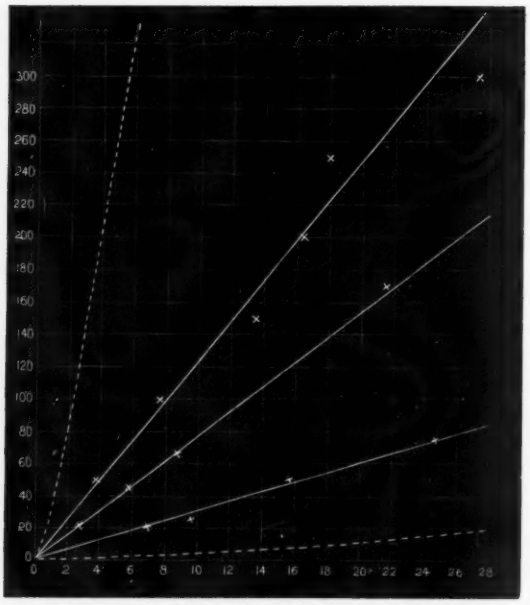


FIG. 7.—DISRUPTIVE DISCHARGE THROUGH DRY WOOD FIBRE.

Very interesting luminous effects take place when a thin sheet of good insulating material, as mica, is placed between the electrodes. At a difference of potential of 830 volts and a thickness of mica of 1·8 milli-centimetres, in darkness, a faint bluish glow becomes visible between the mica and the electrodes. This glow is very perceptible at 970 volts, and faintly visible in broad daylight at 1,560 volts. With increasing difference of potential, this bluish glow increases in intensity, forming a sharply defined smooth, blue line around the electrodes at their point of contact with the mica.

At a difference of potential of 4·5 kilo-volts—thickness of mica of 2·3 milli-centimetres—violet creepers of about 2 mm. length break here and there out of the line of bluish glow. These creepers are distinctly different from the blue glow surrounding the electrodes and increase in number and length with increasing potential, until they form a broad electrostatic aurora surrounding the electrodes on either surface of the mica-sheet, consisting of an infinite number of small violet streamers rushing with a hissing noise over the mica. This corona increases rapidly in width until it reaches the edges of the mica-sheet. Then white sparks of intense brightness pass from electrode to electrode over the surface of the mica, first few in number, then with increasing potential, covering the whole sheet with an infinite number of streaks of lightning, with a roaring noise. The amount of current passing through these sparks is exceedingly small, for no perceptible reaction upon the primary circuit was noticed. The length of these sparks is many times larger than the sparking distance in air, being tenfold at 17 kilo-volts. They are intensely hot, and leave whitish marks, due to calcination, on the mica when passing over it. The sheet of mica and, especially, the electrodes become heated very rapidly, the mica twists and begins to splinter, to separate into sheets, until finally it breaks down.

TABLE V.

DISRUPTIVE DISCHARGE THROUGH PARAFFINED PAPER.

δ = 3 v.

Maximum difference of potential in kilo-volts. V	Sparking distance observed in milli-centi-metres. δ obs.	Electro-static gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centi-metres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %	Remarks. Average of
6·9	21	329	20·7	— ·3	— 1·4	4 re'd's, 3 sht's
9·6	25	384	28·8	+ 3·8	+13·2	3 „ 4 „
15·6	50	312	46 8	— 3·2	— 6·8	1 „ 10 „
24·8	75	331	74·4	— ·6	— ·8	2 „ 15 „
Average		339	Average	± 2·0	± 5·5	

TABLE VI.

DISRUPTIVE DISCHARGE THROUGH MELTED PARAFFIN, 60° TO 70° C.

δ = 12·4 v.

Maximum difference of potential in kilo-volts. V	Sparking distance observed in milli-centi-metres. δ obs.	Electro-static gradient in kilo-volts per cm. g.	Sparking difference calculated in milli-centi-metres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %	Remarks. Average of
3·9	50	78	48	— 2	— 4 2	2 readings.
7 6	100	76	94	— 6	— 6·4	2 „
13·5	150	90	168	+ 18	+ 10 7	3 „
16·3	200	82	202	+ 2	+ 1·0	3 „
18 0	250	72	223	— 27	—12·1	2 „
27·1	300	90	336	+ 36	+ 10·7	1 „
Average		81	Average.	± 15	± 7·5	

TABLE VII.

DISRUPTIVE DISCHARGE THROUGH BOILED LINSEED OIL, 21° C.

δ = 12·5 v.

Maximum difference of potential in kilo-volts. V	Sparking distance observed in milli-centi-metres δ obs.	Electro-static gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centi-metres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %	Remarks. Average of
7·6	100	76	95	— 5	—5·3	
12·1	150	81	151	+ 1	+ ·7	3 readings.
15·5	200	78	194	— 6	— 3·1	4 „
21·3	250	85	266	+16	+ 6·0	4 „
Average		80	Average	± 7	± 3·8	

To determine the difference of potential required for the production of these sparks, a circular disc of mica, of 7 inches diameter and 19 milli-centimetres thickness, was inserted between the electrodes, the E.M.F. increased until the first sparks passed over the edge of the mica, the voltmeter read—then the mica disc cut down to 6 inches diameter and the test repeated, &c. These tests are given in Table XIII. and fig. 8.

The width of the electrostatic corona is half the length of these sparks. The lengh of these sparks depends somewhat upon frequency and the thickness of the mica sheet, being greater for higher frequency, and thinner mica disc, but,

Table VIII.

Disruptive Discharge Through Turpentine Oil.

δ = 15·7 v.

Maximum difference of potential in kilo-volts. v	Sparking distance observed in milli-centimetres. δ obs.	Electrostatic gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centimetres. δ calc.	Difference, $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %
7·1	125	57	112	— 13	— 11·6
12·0	167	72	188	+ 21	+ 11·2
15·6	250	62	245	— 5	— 2·0
Average ...	...	64	Average...	± 13	± 8·3

Table IX.

Disruptive Discharge Through Copal Varnish.

δ = 30 v.

Maximum difference of potential in kilo-volts. v	Sparking distance observed in milli-centimetres. δ obs.	Electrostatic gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centimetres. δ calc.	Difference, $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %
9·7	300	32	291	— 9	— 3·1
20·4	600	34	612	+12	+ 2·0
Average		33	Average...	±10	± 2·6

Table X.

Disruptive Discharge through Crude Lubricating Oil.

δ = 60 v.

Maximum difference of potential in kilo-volts. v	Sparking distance observed in milli-centimetres. δ obs.	Electro-static gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centimetres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %	Remarks. Average of
4·4	300	14·7	264	— 36	— 13·3	...
9·4	600	15·7	564	— 36	— 6·4	2 readings.
15·9	900	17·7	954	+ 54	+ 5·7	2 „
Average		16·0	Average.	± 42	± 8·5	

Table XI.

Disruptive Discharge through Vulcabeston.

δ = 28 v.

Maximum difference of potential in kilo-volts. v	Sparking distance observed in milli-centimetres. δ obs.	Electro-static gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centimetres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %	Remarks. Average of
4·0	100	40	112	+ 12	+ 10·7	3 readings
6·7	200	34	188	— 12	— 6·4	2 „
10·3	300	34	288	— 12	— 4·2	2 „
12·6	355	36	353	— 2	— ·6	1 „
3·7	156	24	104	(— 52)	(— 50)	6 „
Average		36	Average	± 10	± 5·5	

Gets very hot before breaking down.

apparently only in so far as the capacity, or, rather, the charging current of the condenser, represented by the mica disc as dielectric, is increased thereby.

Table XII.

Disruptive Discharge through Asbestos Paper.

δ = 23 v.

Maximum difference of potential in kilo-volts. v	Sparking distance observed in milli-centimetres. δ obs.	Electro-static gradient in kilo-volts per cm. g	Sparking distance calculated in milli-centimetres. δ calc.	Difference $\delta - \delta$ calc. obs. Δ	Difference in per cent. of δ calc. %	Remarks. Average of
2·7	60	45	62	+ 2	+ 3·2	3 readings.
5·0	120	42	115	— 5	— 4·4	3 „
Average		43	Average	± 4	± 3·8	

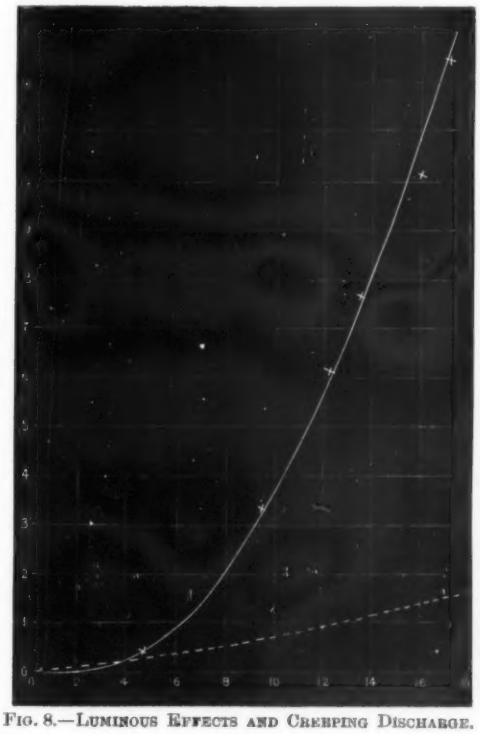


Fig. 8.—Luminous Effects and Creeping Discharge.

Table XIII.

Luminous Effects and Creeping Discharge.

Width of electrostatic corona, $w = 27·5\,(v - 2)^2$.
Length of creeping discharge, $d = 55\,(v - 2)^2$.

Maximum difference of potential in kilo-volts. v	Thickness of mica disc in milli-centimetres. δ	Length of creeping discharge in centi-metres. d obs.	Width of electro-static corona in centi-metres. w	Electro-static gradient in kilo-volts per centi-metre. g	Calculated. d calc.	Difference $d - d$ calc. obs. Δ	Difference in per cent. of d calc. %
·83	1·8	Faint bluish glow between electrodes, visible in the dark.					
·97	1·8	Perceptible bluish glow, visible in the dark.					
1·56	1·8	Considerable bluish glow, faintly visible in broad daylight.					
4·50	2·3	Intense bluish glow; begins to send out short creepers of about ·2 cm. length. Considerable smell of ozone.					
4·50	2·3	·40	·20	11·25	·34	—·06	(—17·7)
9·60	19	3·28	1·64	2·93	3·18	—·10	— 3·2
12·35	19	5·16	2·58	2·40	5·89	+·73	+12·4
13·55	19	7·66	3·83	1·77	7·34	—·32	— 4·3
15·95	19	10·16	5·08	1·57	10·70	+·54	+ 5·0
17·10	19	12·50	6·25	1·37	12·54	+·04	+ ·3
14·90	9	12·50	6·25	1·19	...	...	...
Average						±·30	± 5·0

Table XIV.

Electrostatic Gradients and Specific Electric Resistance.

Material.	Electrostatic gradient at 0	5	25 (kilo-volts, in kilo-volts per centimetre.)	Specific electric resistance in millions of megohm-centimetres.	Remarks.
Air	139	16·7	11·9	∞	
Mica	4,170	3,200	1,660	84	
Vulcanised fibre, red	130	52	15·3	1·2 ?	Slightly damp.
Dry wood fibre ...		130		1·2 ?	
Paraffined paper ...		339		34,000	
Melted paraffin ...		81		...	65° C.
Boiled linseed oil ...		80		...	21° C.
Turpentine oil ...		64		...	
Copal varnish ...		30		...	
Crude lubricating oil (Mineral oil) ...		16		...	Very impure.
Vulcabeston		36		...	
Asbestos paper ...		43		...	
Creeping discharge		10·1	·86	...	

Table XV.

Sparking Distances in Air, in Milli-centimetres.

Difference of potential in kilo-volts.	Own Observations.—Alternate current transformer; $n_1 = 150$ periods; Discs of 5 cm. diameter.		Alex. Siemens (London).—Alternate-current transformer; $n_1 = 100$ periods; discs of 10 and 3·7 cm. diameter.—(*Elektrotechnische Zeitschrift*, 1892, No. 19, p. 246.)		Bourne.—Swinburne transformer; Plates of 6·3 cm. diameter—(*Electrical Engineer*, N.Y., 1892, No. 205, p. 361.)		A. Schneller.—Alternate-current transformer; Ratio, 1 : 200.—(*Elektrotechnische Zeitschrift*, Germany, 1890, No. 46, p. 589.)		Balls of 3 cm. diameter.—(Uppenborn, Kalender für Electrotechniker, 1893, p. 97, Germany.)	
V	δ obs.	δ calc.	δ obs.	δ calc.	δ obs.	δ calc.	δ obs.	δ calc.	δ obs.	δ calc.
1	30	29	24	...	...	...	...	...	...	...
2	77	80	48	...	...	...	...	...	...	...
3	132	138	73	...	...	...	...	...	...	...
4	192	199	105	...	...	...	250	290	90	...
5	255	264	139	144	150	165	320	380	116	...
6	323	331	171	176	...	...	440	470	147	...
7	396	401	206	209	...	...	600	590	177	...
8	468	473	240	242	...	...	730	710	208	205
9	540	547	277	278	...	...	900	830	240	237
10	622	624	317	316	300	362	1,030	960	273	270
12	800	785	400	393	...	...	1,320	1,260	343	341
14	988	955	480	473	...	...	1,600	1,570	416	417
15	...	...	...	...	570	590	...	...	...	...
16	1,173	1,135	598	...	...	...	1,900	1,910	483	490
18	1,320	1,325	755	...	...	...	2,200	2,280	550	551
20	1,476	1,524	940	...	1,000	850	2,580	2,690	615	612
25	2,200	2,064	...	...	1,300	1,140	3,700	3,850	768	765
30	...	2,660	...	...	1,610	1,460	5,300	5,180	918	918
35	...	3,320	...	...	1,930	1,810	7,200	6,350	...	...
40	...	4,040	...	...	2,240	2,190	...	...	...	...
45	...	4,820	...	...	2,600	2,610	...	...	...	...
50	...	5,660	...	...	3,100	3,050	...	...	...	...
60	...	7,520	...	...	4,100	4,030	...	...	...	...
70	...	9,620	...	...	5,100	5,130	...	...	...	...
80	...	11,960	...	...	6,350	6,370	...	...	...	...
90	...	15,740	...	...	7,600	7,710	...	...	...	...
100	...	17,360	...	...	9,330	9,200	...	...	...	...
110	...	20,420	...	...	11,100	10,790	...	...	...	...
120	...	23,720	...	...	...	...	...	...	...	...
125	...	25,460	...	...	...	...	...	...	...	...
	$\delta = 36\left\{e^{\cdot 13\,v} - 1\right\} + \cdot 54\,v + 1\cdot 2\,v^2$		$5 \leqslant v \leqslant 14,$ $\delta = 26\,v + \cdot 555\,v^2$		$\delta = 30\,v + \cdot 62\,v^2$		$\delta = 58\,v + 3\cdot 84\,v^2$		$8 \leqslant v \leqslant 14,$ $\delta = 20\,v + \cdot 7\,v^2$	
									$v \leqslant 14,$ $\delta = 30\cdot 6\,v$	

Table XV.—*Continued.*

Sparking Distances in Air, in Milli-centimetres.

Difference of potential in kilo-volts.	Balls of 1 cm. diameter.—(Uppenborn, *Kal. f. Electr.*)		Balls of 5 cm. diameter.—(Uppenborn, *Kal. f. Electr.*)		Warren de la Rue and H. Muller.—Silver—Chloride of Silver—Sal Ammoniac—Zinc Battery.—(Mascart and Joubert, *Electricity and Magnetism*, Vol. II., p. 198).		S. W. Thomson.—Between discs.—(Mascart and Joubert, Vol. II., p. 196).		Mascart.—Electrostatic machine; balls of 2·2 cm. diameter.—(Mascart and Joubert, Vol. II., p. 197).		Macfarlane.—(Mascart and Joubert. Vol. II., p. 196.)	
V	δ obs.	δ calc.	δ obs.	δ calc.	δ obs.	δ calc.	δ obs.	δ calc.	δ obs.	δ calc.	δ calc.	δ calc.
1	13	...	13	...	21	20	13	17	...	...	...	
2	30	...	30	...	43	42	42	39	...	...	...	
3	52	...	54	...	66	66	62	66	...	...	...	
4	78	...	80	...	91	91	100	97	...	...	112	
5	105	...	108	...	118	118	127	132	90	...	135	
6	133	...	134	...	147	148	...	...	...	...	160	
7	162	...	161	...	180	180	...	...	...	...	172	
8	190	190	189	...	215	213	...	...	...	...	213	
9	220	220	220	...	250	248	...	...	...	...	260	
10	254	250	252	...	286	287	...	...	180	...	305	
12	320	314	320	...	365	367	...	...	...	...	405	
14	388	384	3-7	...	...	...	...	...	...	...	505	
15	...	...	...	...	...	...	...	...	270	...	...	
16	460	458	460	...	...	...	...	...	...	...	605	
18	538	536	530	..	...	...	...	...	...	...	705	
20	623	620	608	...	...	...	...	...	360	...	800	
25	940	...	804	...	...	...	...	...	450	...	...	
30	...	...	1,053	...	...	...	...	...	570	...	...	
35	...	...	...	...	...	...	...	...	690	...	...	
40	...	...	...	...	...	...	...	...	800	...	...	
45	...	...	...	...	...	...	...	...	900	...	...	
50	...	...	...	...	...	...	...	...	1,100	1,090	...	
60	...	...	...	...	...	...	...	...	1,700	1,700	...	
70	...	...	...	...	...	...	...	...	2,430	2,430	...	
80	...	...	...	...	...	...	...	...	3,300	3,300	...	
90	...	...	...	...	...	...	...	...	4,370	4,290	...	
100	...	...	...	...	...	...	...	...	5,800	...	...	
110	...	...	...	...	...	...	...	...	7,500	...	...	
120	...	...	...	...	...	...	...	..	10,350	...	...	
125	...	...	...	...	...	...	...	...	12,600	...	...	
	$8 \leqslant v \leqslant 20$ $\delta = 19\,v + \cdot 6\,v^2$				$\delta = 18\cdot 84\,v + \cdot 977\,v^2$		$\delta = 15\,v + 2\cdot 3\,v^2$		$50 \leqslant v \leqslant 90$ $\delta = -10\cdot 7\,v + \cdot 65\,v^2$		$100 \leqslant \delta \leqslant 1,000$ $v = 20\sqrt{\delta^2 + 205\,\delta \times 10^{-3}}$	$v = 20.000\sqrt{\delta^2 + 205\,\delta}, \quad \cdot 1 \leqslant \delta \leqslant 1\cdot 0$

Since these sparks behave entirely different from an arc passing between the electrodes, and are usually unable to start an arc, I believe they are merely a condenser phenomenon. That is, I explain it so, that the corona is the charging current of the condenser formed by the mica disc as dielectric, and the whole surface covered by the corona as condenser plate, while when the corona reaches the edge of dielectric, disruptive discharge of the condenser takes place, by these sparks passing over the edge of the dielectric.

I do not know whether this explanation really covers the phenomenon, but merely offer it as a suggestion. Of all the high-potential phenomena, this is undoubtedly the most brilliant.

Referring now to the tables and figures;

Table I., fig. 4, disruptive discharge through air.
II., 5, " " " mica.
III., 6, " " " vulcanised fibre.
IV., 6 & 7, " " " dry wood fibre.
V., 7, " " " paraffined paper.
VI., 7, " " " melted paraffin.
VII., " " " boiled linseed oil.
VIII., " " " turpentine oil.
IX., " " " copal varnish.
X., " " " crude lubricating oil.
XI., " " " vulcabeston.
XII., " " " asbestos paper.
XIII., fig. 8, luminous effects and creeping discharge.
XIV., electrostatic gradients and specific electric resistances.

In figs. 6 and 8, the air-curves, and in fig. 7, the air and the mica curves are drawn in dotted lines for comparison.

As seen from Table XIV., the electrostatic gradients and the specific electric resistances have no relation with each other.

As a curiosity, it may be remarked that by extrapolating the speaking distance by means of the empirical formula of Table I.,

$$\delta = 36\ (e^{-1\cdot3\,v} - 1) + 54\ v + 1\cdot2\ v^2,$$

we would get for 100,000 volts, a sparking distance of about 7 inches ; for a quarter-million volts, a sparking distance of 3 feet ; for one million volts, 40 feet sparking distance ; while a lightning stroke of one mile in length would require 11,000,000 volts.

It will be of interest now to compare the results of the tests, especially of the sparking distance in air, with those found by other experiments. In Table XV. I have collected all the tests which were available to me, and represented a part of them in fig. 9 ; with a very discouraging result, however, for the values found by different observers disagree seriously.

Conceding even a large margin of uncertainty for the older tests, made by electrostatic machines, and leaving out of consideration those tests, where not sufficient explanation was given to permit critical discussion of the method, the discrepancies are still too large to permit of explanation by errors of observation. The different curves differ considerably in shape ; the best and most reliable values, however, fairly well point to a formula :

$$\delta = a\ v + b\ v^2.$$

The tests made by Warren de la Rue, which were made by the chloride-of-silver battery, and hence are the only continuous potential tests free from the objection due to the electrostatic machine, agree completely with this formula, over the whole range up to 11,330 volts. Bourne's tests by means of alternating potentials, reaching up to 110,000 volts (?) agree fairly well also over the whole range. Other tests again show agreement with a quadratic formula only within a limited range.

Most noticeable, however, is the wide disagreement between the values of different observers, which seems to show that still other factors besides the difference of potential have a decisive influence on the sparking distance. Especially I suspect the frequency, for the values found with continuous potentials show the smallest, those with alternating potentials the largest distances, so that I almost believe that the sparking distance in air is larger with alternating than with continuous potentials, and is the larger the higher the frequency is. This whole phenomenon of disruptive discharge, however, has been so little studied, in spite of the great importance it begins to assume by reason of the problem of long distance power transmission, that a closer investigation of the manifold phenomena connected therewith is very much to be desired.

Eickemeyer Laboratory, December 1892.

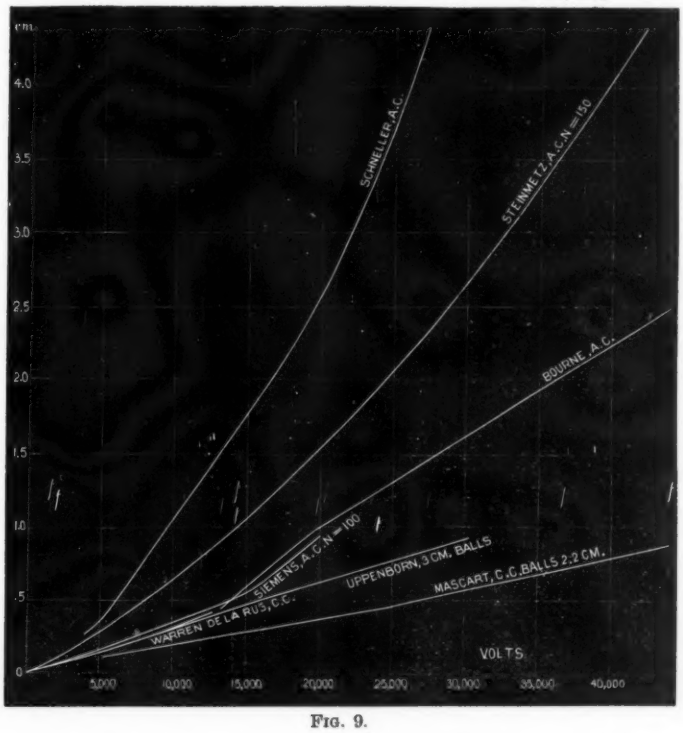


FIG. 9.

REVIEWS.

Telephone Lines and their Properties. By W. J. HOPKINS, Professor of Physics in the Drexel Institute of Art, Science, and Industry, Philadelphia. London : Longmans, Green and Co.

Written, as this book is, by an American, and dealing with the subject from a purely American point of view, it will give the English reader an insight into the American method of erecting lines, &c.

With the theoretical portion of the work we are disappointed, as the author does not appear to have properly grasped his subject, or at least, has failed to make it evident that he has mastered it. For example, in Chapter XIII., which deals with the "Properties of metallic circuits," the writer states with reference to the capacity of the two wires of a metallic circuit : "The capacity to earth may be any quantity whatever so long as it is the same for each wire, without affecting the condition of the two wires as a circuit. For a metallic circuit constitutes a condenser, of which each wire of the circuit is one of the plates. Now, the capacity of a condenser depends upon the surface of the plates and their distance apart ; and it is unchanged by the proximity of a third plate, provided the third plate is at the same distance from each plate of the condenser." Now the absurdity of this statement is evident, if we consider two wires to be, say, 20 feet apart, and each wire, say, 1 inch above the surface of the ground ; according to the author the capacity between wire and wire under these conditions would be the same as if the wires were, say, 100 feet above the earth's surface, whereas actually, when the wires are close

to the earth, as at first stated, the capacity between wire and wire is practically that of two wires 2 inches apart, the intermediate distance of 20 feet having practically nothing to do with the question; but the reverse is the case when the wires are high above the earth, for then the distance between the wires is small compared with the distance above the earth, and *then* (and only then) does the latter become a negligible factor in the capacity.

"Mutual induction" between the two wires of a metallic circuit is discussed as being of no account, whereas, in fact, it is a most important factor determining the speaking distance of a circuit. If it were not for this mutual induction the "K. R." law, about which so much has been said, would be strictly true as it was first enunciated. There is, indeed, in the book a good deal more which could be taken exception to, whilst a very large amount of the theoretical matter is really little more than "much ado about nothing," and of very little practical value. The consideration of the transposition system of crossing metallic circuits is of more value, and is of interest.

In speaking of the introduction of several instruments on one circuit, the author credits the "Bridge" system to Mr. J. J. Carty. We pointed out, however, some time ago in the pages of the Review, that this arrangement was introduced in the telephone system of the British Postal Telegraph Service at a very early stage of the invention of the telephone, and long before Mr. Carty brought it forward.

The use of "paper" cables for underground work is referred to, and it is stated that "any small quantity of moisture in such a cable is absorbed and distributed by the dry parts, and provided the sheath does not continually admit moisture, the insulation rises again." This is an important fact, as it has often been suggested that the entry of a small quantity of moisture would be permanently fatal to the insulation.

"The subject of exchanges has been taken up principally to round out the scope of the book," the author says in his preface, and for much of the matter under this head he is indebted to the writings of others not of very recent date. The consequence is, that though interesting, it does not represent in every respect most recent practice.

Marine Electric Lighting. Rochdale: E. Wrigley & Sons, Limited.

This work is issued as an annual by *Electrical Plant.* It is not a treatise on the theory or practice of the subject upon which it treats. There is far too much of the trade catalogue about it, certain manufacturers are again and again referred to, in fact, the bulk of the work is a trade description of work done and plant made by two or three engineering firms.

The small high-speed steam engine, separately, and combined with a dynamo, is, no doubt, a very useful article of commerce, but it is too common a piece of machinery to excite much interest, yet it is illustrated and described in page after page *ad nauseum.* The steam turbine is the only novelty shown in illustrating engines, but there is no description given of this interesting motor, and the illustration is not the most recent of Parsons's design; besides the great number of engines, all of similar types, the descriptions and illustrations of which fill up the pages of most of the chapters, we have a plate showing another six or eight combined engines and dynamos, for what purpose or with what object in view this book sayeth not; the same illustrations are shown weekly in half-a-dozen technical journals in their advertisement pages.

The chapters on torpedoes and on search lights or projectors are not so catalogie; these subjects being dealt with in a general way without going into details.

The transmission of power on board ship by electricity ought to have been more fully treated, not so much from the point of view of what has been done in that line, but with an idea of what could be done. The discussion on the single *versus* double wiring of ships is very complete, but leaves the question very much where it was, and it is likely to remain there. We believe single wiring has been very largely adopted, and with great success; and we understand double wiring is also successful. Superiority is claimed for single wiring on the ground of greater safety; the objection to it on the ground that it affects the compass has no foundation in practice. Single wiring is never entirely carried out in practice, and main branches passing near compasses are always double wires; groups of lights are double wired back to a common earth wire, earthed some distance from the lights in many cases; in no case is every light separately earthed to the frame of the ship.

In ship fittings (and we might also say in house fittings) great advantages are found in single wiring, using central contacts; single wired fittings may be used on either single or double wired ships.

The chapter on "Electricity in Lighthouses" is very good. The electric fan shown on the last page seems to have a motor out of all proportion to the fan attached to it. In illustrating this important branch of electrical engineering some of the many combinations of fans and motors might have been selected showing how compact the combination can be made.

A fan and motor combination is shown in fig. 5, page 40, such as is used in the French navy. This is the only other combination shown in fans.

The work is well got up, and the illustrations and letterpress are beautifully printed.

The Art of Projecting: A Manual of Experimentation in Physics, Chemistry and Natural History, with the Porte Lumière and Magic Lantern. By Prof. A. E. Dolbear, M.E., Ph.D. (Tufts College), Boston, U.S.A., 1892: Lee & Shepard.

This book is in many respects unique, since it contains plain and concise instruction respecting those difficulties of manipulation which the lecturer making use of screen projections usually has to solve or evade for himself. The letterpress is accompanied by upwards of a hundred illustrations, which seldom fail to elucidate the matters discussed. Since this book was first published, electric lighting has become a great industry, and the arc-lamp, which can now be used with great steadiness, stands pre-eminent amongst the artificial sources of light which are employed in projecting. A regulator is not specially needed, for the carbons burn but slowly, and hand regulation does not much interfere even with protracted lectures, whilst the brilliancy of the pictures surpasses many times the best possible with the oxyhydrogen light. Automatic regulation is a great convenience, however, but both carbons must move for lantern work. Although the management of a lantern, when the electric light is used, is explained in a manner which leaves little to be desired, and experiments covering the whole range of physics are carefully described, it appears to us that those given under the headings of magnetism and electricity are remarkable chiefly for their paucity. The printing, binding and general arrangement of the book is excellent.

Matter, Ether and Motion: the Factors and Relations of Physical Science. By A. E. Dolbear, Ph.D., Professor of Physics in Tufts College. Boston: Lee & Shepard, 1892.

"What fifteen years ago was deemed *possible*, is to-day deemed *probable* and to-morrow may be demonstrated." this quotation illustrates the spirit in which Prof. Dolbear endeavours to describe the fundamental notions of modern physics. He recognises that the factors common to all phenomena are the same, namely matter, ether and motion, so that the so-called "forces of nature" considered as objective things controlling phenomena have no existence. The title of the book clearly indicates the trend of thought underlying the text. The hypothetical ether which Grove in the forties contemptuously referred to as "the clothes-horse upon which to hang the unknown" is, to Prof. Dolbear, a definite reality or nearly so: thus he reflects the most advanced phase of thought amongst modern physicists. He undertakes to present in a systematic way the mechanical principles that underlie the phenomena in each of the departments of natural philosophy in a readable form free from technicalities, and we are bound to say that he succeeds. The chapters entitled "Chemism," "Life" and "Physical Fields," are especially interesting. In the first the author betrays his nationality—our American contemporaries have a weakness for doctoring scientific terms. The chapter on Life might reasonably be unexpected in a treatise on physics, and illustrates the com-

pleteness with which the subject has been surveyed; that on Physical Fields is unique and extends the principle of sympathetic action which has been recognised in acoustics to the whole range of phenomena—even to living phenomena. The subject has been handled in a fresh and buoyant style, the science is sound and the book is full of evidence that the author "has kept his finger on the pulse" as it were of modern thought.

NEW PATENTS—1893.

7,297. "Improvements in and connected with secondary batteries, applicable also to primary electric batteries." W. J. S. BARBER-STARKEY. Dated April 10th.

7,342. "An improved system of conductors for the distribution of electrical energy, and in apparatus used therefor." A. BERGTHEIL and R. A. MARPLES. Dated April 10th.

7,358. "The gipsy telephone or electric mahatma." J. WOOD. Dated April 11th.

7,387. "Improvements in or relating to machines for electrically welding metals." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated April 11th.

7,389. "Improvements in apparatus for electrically welding or working metals." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated April 11th.

7,404. "Improvements in globes, shades, saucers, glasses, incandescent lamps, lanterns, and other appliances used for diffusing and increasing the light arising from electricity, gas, candles, mineral, and other oils." J. LONG. Dated April 11th.

7,407. "Improvements in electric meters." J. W. JONES. Dated April 11th.

7,423. "Improved means for telegraphing." W. H. FAHRNEY. Dated April 11th. (*Complete.*)

7,424. "Improvements in electric arc lamps." A. G. WATERHOUSE and THE WATERHOUSE ELECTRICAL MANUFACTURING COMPANY, LIMITED. Dated April 11th.

7,437. "An improved microphone." H. H. LEIGH. (Communicated by C. Mildé, Son & Co., France.) Dated April 11th. (*Complete.*)

7,470. "Improvements relating to electric railways, tramways, and the like." P. WILLIS. (Communicated by J. B. Sheldon, G. L. van Beek, and D. J. Murnane, United States.) Dated April 12th.

7,471. "Improvements in and connected with electric annunciators." E. R. WILDER. Dated April 12th. (*Complete.*)

7,488. "Improvements in electric battery apparatus." J. A. ARCHER. Dated April 12th.

7,491. "Improvements in or relating to incandescent electric lamps." T. ODDY. Dated April 12th.

7,509. "Improvements in incandescent electric lamps." J. COOPER. Dated April 12th.

7,561. "Improvements in electric railway signalling." I. A. TIMMIS. Dated April 13th.

7,581. "Improvements in electric arc lamps." A. D. LEWIS and F. M. LEWIS. Dated April 13th.

7,594. "Improvements in the electrolytical decomposition of chlorides and mixtures thereof, and in apparatus for the purpose." F. M. LYTE. Dated April 13th.

7,600. "Improvements in electrical heating apparatus." Sir D. L. SALOMONS. Dated April 14th.

7,623. "Improvements in methods of and apparatus for the conversion of the energy of electricity into that of light." R. WOOD. Dated April 14th.

7,645. "Apparatus for showing the phenomena resulting from the application of heat to crystals and other substances, and for slides generally requiring heat for use with microscopes and polariscopes, the heat being generated by means of electric energy." Sir D. L. SALOMONS. Dated April 14th.

7,647. "Improvements in rapid telegraphic transmission." C. LANGDON-DAVIES. Dated April 14th.

7,687. "A new or improved conductor for electric and telephone wires." N. D. I. O. GOLD. Dated April 15th.

7,697. "Improvements in dynamo-electric and electro-dynamic machines." H. ROBINSON. Dated April 15th.

7,702. "Improvements in electric signalling apparatus and systems for railways." J. Y. JOHNSON. (Communicated by J. W. Lattig and W. F. D. Pascoe, United States.) Dated April 15th. (*Complete.*)

7,703. "Improvements in electric signalling apparatus and systems for railways." J. Y. JOHNSON. (Communicated by J. W. Lattig and W. F. D. Pascoe, United States.) Dated April 15th. (*Complete.*)

7,711. "Improvements in electrical accumulators or secondary batteries." P. SCHOOP. Dated April 15th.

7,713. "Improved gland joint for electrical conductors." W. C. JOHNSON. Dated April 15th.

7,714. "An improvement in electric targets." A. J. H. WYATT. Dated April 15th.

7,722. "Improvements in fabric for medical electric appliances or the like." J. H. HAYWOOD. Dated April 15th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

11,712. "Improvements in or connected with electric batteries." H. C. BULL. Dated July 9th. Relates to a particular arrangement of the Jablochkoff coke battery described in the specification of letters patent dated February 5th, 1877, No. 492, the exciting liquid being nitrate of potash, nitrate of soda, or any other nitrate which may be found to work satisfactorily, they being maintained in a liquid state by heat. 4 claims.

13,492. "A method and apparatus for electrical propulsion of vehicles." F. E. ELMORE. Dated August 10th. Claims:—1. The described method of propelling a vehicle electrically by the alternate attraction and repulsion of the poles of alternating electro-magnets carried on the vehicle by teeth of stationary iron bars inductively magnetised from an electro-magnet of constant polarity also carried on the vehicle. 2. For effecting electrical propulsion in the manner above referred to, a vehicle carrying a constant electro-magnet and several alternating electro-magnets in combination with stationary toothed iron bars, substantially as described.

14,096. "Combination electric lock." J. G. THOMPSON. Dated August 20th. Consists in the combination with the lock operating levers, of an electro-magnetic controlling device, a circuit including said controlling device, and a suitable source of electricity, combination circuit setting and closing devices, and a short circuit safety device. More specifically, the controlling device consists of a locking device, a revolving disc having means for engaging the locking device and lever, a ratchet by which the disc may be rotated, a pawl adapted for engagement with the ratchet, and an armature of an electro-magnet for operating the pawl. 34 claims.

14,834. "Improvements in and connected with electrically propelled vehicles." W. E. HEYS. (Communicated from abroad by C. Brown, of Paris.) Dated September 2nd. According to these improvements three pairs of wheels are employed, of which the front and rear pairs are motor wheels, and the middle pair bearing wheels. 5 claims.

15,834. "Improvements in carriers for conical shades for electric or other lamps." B. M. DRAKE and J. M. GORHAM. Dated September 18th. The inventors form, in a tripod carrier, two arms with their ends bent so as to receive the edge of the shade in the usual way, but at the extremity of the third arm, they make the clip movable, and attach to it a spring, which tends to draw it radially toward the centre. 1 claim.

16,250. "Improvements in dynamo machines." R. HAMMOND and C. J. HALL. Dated September 24th. The conducting coils of the armature are combined with laminated iron in the form of segments, which are arranged as a ring surrounding the path of the field magnets. Each segment—with a conducting coil—is adapted to be removed from the armature with great facility, so as to be readily replaced by an interchangeable segment and coil, whenever a coil becomes defective. 6 claims.

16,293. "Improvements in the method of and in the means for propelling ships and other vessels electrically." W. E. HEYS. (Communicated from abroad by J. J. Heilmann and F. Drouin, both of Paris.) Dated September 25th. According to these improvements the propeller or propellers is or are put in movement by means of electromotors, which derive their current from a dynamo or dynamos driven by steam engines or other prime movers carried on board. The electric transmission of power to the propellers permits a convenient speed to be given to the screw, and, in particular, it allows the dimensions of the screw to be diminished and its speed increased, which conditions are known to be favourable to efficiency.

16,977. "Improvements in lightning rod staples." H. C. WHINCOP. Dated October 6th. The inventor forms his improved staple with a shank about 4½ inches in length by about ⅜ths of an inch in width (more or less) and with a head about 2½ inches by one inch; the improved staple when viewed horizontally would present to view the edge of head and the face of shank, the shank-face extending unbroken about ⅔ of its total length and then branching to the right and to the left, forming two distinct arms; a series of inclined planes are formed on the face of shank and also extended over both of the arms of shank. The staple when viewed edgeways presents a vertical view of the inclined planes and notches, the projection of each notch is, in some cases, formed with a slight outward bevil for convenience of moulding for casting, in other cases it is under cut or inclined inwards, forming at the apex an acute compressible angle, the apex of the notch then tapering downwards until it reaches the root of next notch. 3 claims.

16,991. "Improvements in type printing telegraphic apparatus." F. H. W. HIGGINS. Dated October 6th. The inventor employs two type wheels upon a single axis which is rotated as usual either by an escapement or propelment; he also provides a movable shield which is operated by an electro-magnet or magnets in the same circuit with, but independent of, those employed for the rotation of the type wheel or for moving the impression lever and incapable of impeding the motion of either. In this circuit currents alternately positive and negative pass. 5 claims.

18,251. "Improvements in electricity meters." SIEMENS BROS. AND CO., LTD., and F. G. BAILY. Dated October 23rd. At or near the origin of a spiral is pivoted the axis of an index, which carries a soft iron armature in the shape of a deep fork embracing the spiral bar, one prong of the fork being on each side of the bar, but without touching it. The armature is counterbalanced by a weight on the

opposite end of the index, and the axis of the index is attached to the inner end of a volute spring, the outer end of which is fixed. When an electrical current is transmitted through the spiral, the closed end of the armature fork is attracted towards the spiral, and consequently the index is made to make a partial revolution in opposition to the spring until the closed end of the fork comes to such a position relatively to the spiral, that the tendency to move the index farther round is just balanced by the torsive strain exercised by the spring. 1 claim.

18,505. "A new or improved electric circuit controller or appliance." W. B. CLEVELAND. Dated October 27th. The objects of the invention are to provide improved means for cutting out a portion of an electric light or power circuit in cases of emergency, such as in case of breaking or dropping of the wires of the circuit in case of wires of another circuit coming into dangerous contact with the wires of the circuit, or in similar emergency cases to provide improved means for admitting of such cutting out being safely and completely performed by a non-expert, and to provide improved means for smothering and extinguishing the arc formed by the contact members in the act of separating them and cutting off the circuit. 5 claims.

CORRESPONDENCE.

Single and Combination Couplers.

I have read with interest your article in a recent number of the ELECTRICAL REVIEW on "Joint-Boxes on Underground Networks," and I much admire the appliance, designed by Mr. Bowden for use in connection with high tension currents, which you illustrate therein.

It may interest some of your readers if I supplement the article by a short description and diagrams illustrating a method, adopted on low pressure mains where the Callender class of insulation is used, by which distributing, connecting, and feeding, mains can be readily disconnected for various purposes.

Some time ago I had occasion to design for the Chelsea Electricity Supply Company a mechanical joint or coupler, which would act as a switch to divide the system of mains into sections whenever it was necessary to stop for more than one hour the supply in any portion of the mains affecting the premises of a number of consumers, and thus meet the requirements of the Board of Trade.

The coupler is illustrated in fig. 1. which clearly shows the arrangement of parts; it is 4 inches long.

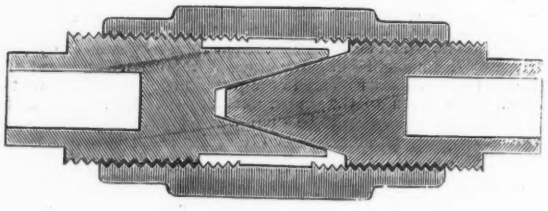


FIG. 1.

After the cable is cut, the ends of the conductor are sweated into the cups of the coned pieces; the two coned pieces are then screwed together by means of the covering nut, which is provided with a right and left handed thread, till the coned

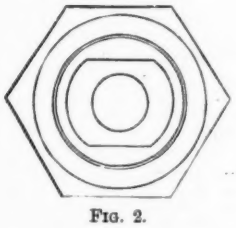


FIG. 2.

surfaces are securely coupled up. To prevent the cables turning these coned pieces are provided with flats at their outer ends, as shown in fig. 2, which is an end view of the coupler, and held by spanners while the covering nut is being turned.

The coupler is then insulated to correspond with the cable, or by a vulcanised rubber sleeve which can be fitted over one end of the cable before the coupler is connected up, and afterwards drawn over the metal.

These couplers have been successfully in use on the Chelsea Electricity Supply Company's mains for some time. This form was specially designed with a view to maintaining the conductivity of the joint, and it has been found to fulfil this condition so well that I adhered to a similar form of coned surfaces in designing the *combination coupler* for the feeding points in the system of mains. This pattern now takes the place of the jointing pieces that were originally used by the company, and which have on former occasions been illustrated. Fig. 3 is a section of the combination coupler, and clearly

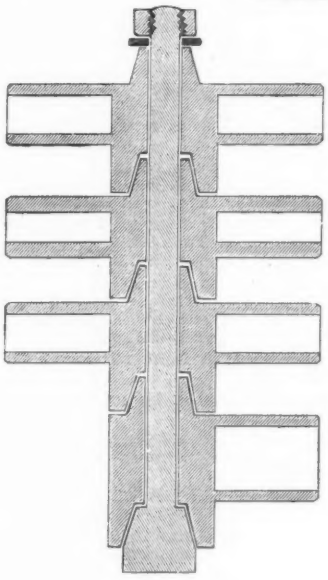


FIG. 3.

shows the arrangement of the parts, and also the elasticity and compactness of design. The lower end of the bolt has a square head where it projects beyond the cone, and a hole drilled through it (neither shown in the figure), either of which affords means of holding the bolt from turning when the pieces are being securely coupled up. The one illustrated is for use on one of the poles of the mains, and is arranged to take one feeder, one connecting, and five distributing mains, provision also being made for connecting the pressure wire through a fuse to the feeder: it is about 11 inches by 6 inches; but the number of pieces can be increased or reduced at will, according to the number of cables to be connected up, it merely necessitating a longer or shorter bolt corresponding with the number of pieces. The cups are bored out to suit the different sized cables between the maximum and minimum without altering the pattern. It is sometimes desirable to have the cups on the individual pieces at right angles instead of in the same line as shown. All the pieces are made interchangeable, and it can be seen that they can be moved round the bolt to any suitable angle before being finally fixed.

The ease with which any part can be disconnected by simply withdrawing the bolt, and re-coupled again, makes it an extremely convenient device for the purpose of testing, or for disconnecting a section of the distributing mains. It is not necessary to electrically disconnect all the pieces at once. Flexible connections and clamps can conveniently be used to avoid breaking continuity while removing any piece separately.

This coupler has been working satisfactorily on the Chelsea Company's mains. It is insulated in a similar manner, as previously described. The metal of the couplers is very carefully tinned, and the coned surfaces are all turned in the lathe. Both patterns are used in surface boxes. The combination couplers are used at the feeding points, where the surface boxes are of ample dimensions.

W. Howard Tasker.

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